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BIOLOGIA CENTRALI-AMERICANA.

ZOOLOGY, BOTANY, AND ARCHÆOLOGY.

EDITED BY

FREDERICK DUCANE GODMAN, D.C.L., F.R.S.,

AND

OSBERT SALVIN, M.A., F.R.S.

INTRODUCTORY VOLUME.

BY

FREDERICK DUCANE GODMAN, D.C.L., F.R.S.

1915.

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To My Beloved Wife

ALICE MARY GODMAN

who has taken the deepest interest

and given me

much assistance and sympathy

in the completion of

this work

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PREFACE.

I FEEL that an apology, as well as an explanation, is due to the subscribers of the 'Biologia Centrali-Americana' for the length of time that has been occupied in the production of this work. When it was commenced, in September 1879, it was estimated in our prospectus that, when completed, the Zoology would "not much exceed sixty parts, equivalent to about twelve volumes of 500 pages each," and that twenty parts would suffice for the Botany, the two subjects to be issued concurrently. The inclusion of the Archæology was not at that time contemplated, and this subject was only undertaken later in consequence of the investigations made by my friend Mr. A. P. Maudslay of the famous ruins in Central America, which, together with his beautiful photographs, made a valuable addition to our knowledge of the country. We had, moreover, underestimated the vast amount of additional material which subsequently came into our possession, and thus necessitated the extension of the work to a total of 215 parts, or 63 volumes.

It had been our intention at the termination of the work, and after a careful study of the Zoological and Botanical material accumulated from this hitherto little-known but exceedingly rich country, to have summarised the result and discussed its bearing on the interesting subject of geographical distribution. Salvin's death after a long illness, and my own advancing years and ill-health, compelled me to abandon this project, and I should have been obliged to content myself with the conclusions arrived at by the various contributors in their respective Introductions had it not been for the assistance of Messrs. R. I. Pocock and C. Tate Regan, to whom I am greatly indebted for their respective articles on the Mammals, Reptiles, Fishes, Arachnida, Chilopoda, etc., which are included in the Indroductory Volume. As regards the Insecta generally, which occupy such a large portion of the work, so little is as yet known of the fauna of other tropical regions that no satisfactory comparison can be made.

Mr. W. B. Hemsley, who had previously contributed the volumes on the Botany, had almost completed an article on the geographical distribution of the Flora, practically bringing this subject up to date, when, I regret to state, his health completely failed, and he was reluctantly obliged to relinquish his task. Recently he has, however, been able to furnish me with a *précis* of his conclusions, which forms a valuable addition to our knowledge of the subject.

It now only remains for me to offer my grateful acknowledgments to all those who have assisted me with their various contributions, and without whom the work could not possibly have been undertaken. To my Secretary, Mr. G. C. Champion, I am specially indebted for the valuable assistance he has rendered as collector, contributor, and also as subeditor, in which last capacity his advice has been of inestimable value. His knowledge of Entomology, especially of Coleoptera and Rhynchota, has made him one of our most important contributors, and he has either undertaken alone, or shared in the production of, no less than nine volumes of the 'Biologia.' My warm thanks are also due to my assistant, Mr. A. Cant, who has given very important help during the progress of the work, both in setting the insects, in labelling and arranging them, as well as in making very careful dissections and preparing slides for microscopic examination.

F. D. G.

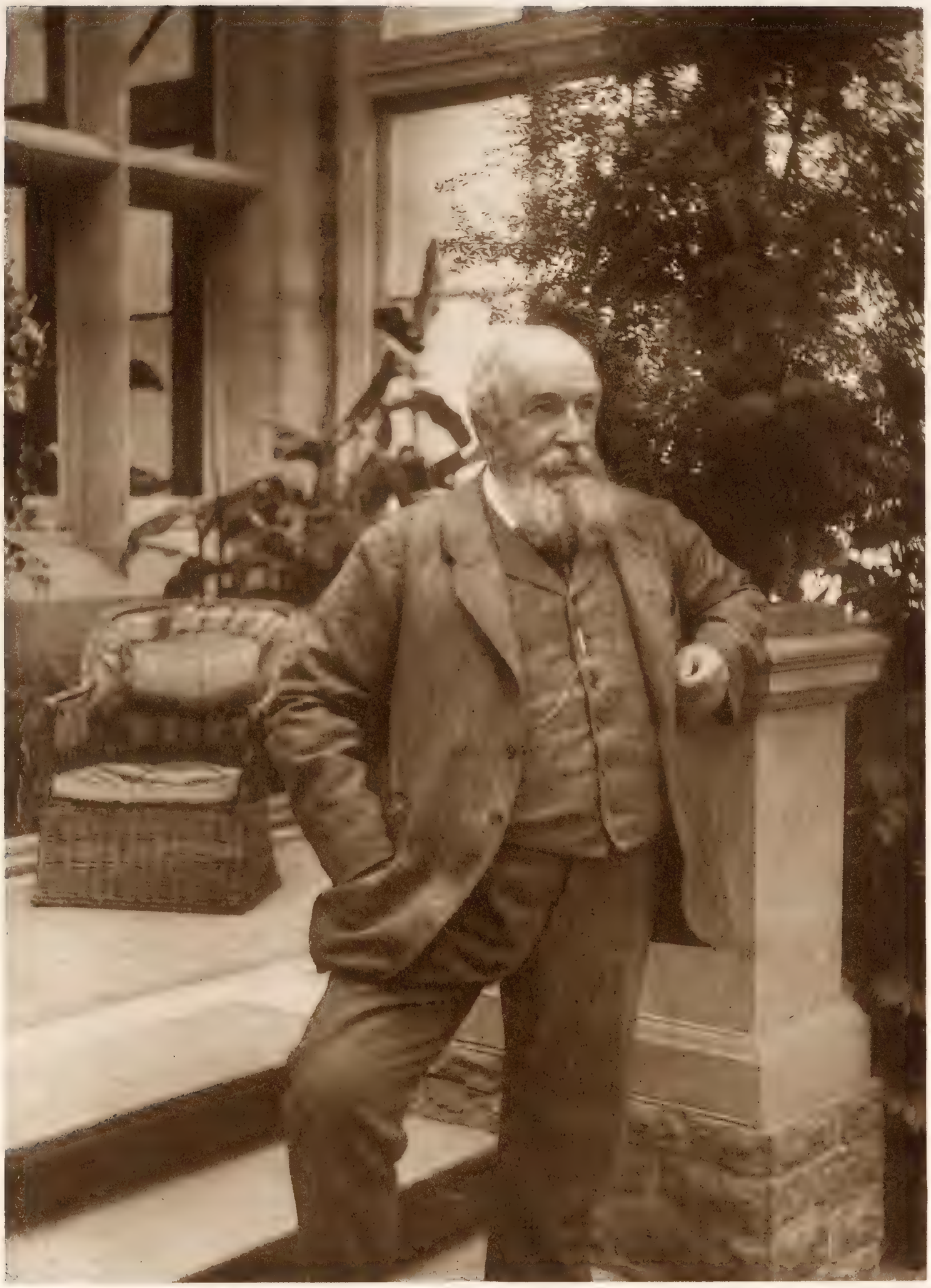
June 1915.

PLATE I.



F. D. Godman.

PLATE II.



Albert Salvin.

INTRODUCTION.

A SHORT account of the events that led to the publication of the 'Biologia Centrali-Americana' may be of interest to our readers, and I will therefore first give a sketch of the early days of Salvin and myself, so far as they have a definite bearing on the study of Natural History, and of the circumstances which drew our attention especially to Tropical America.

Osbert, the second son of Mr. Anthony Salvin, the eminent architect, was born at Finchley in 1835 and educated at Westminster and Cambridge. That he developed a very early taste for natural history is clear from the series of bird skins, now in the Natural History Museum, collected by him as a boy and labelled 'Finchley.'

I, Frederick DuCane Godman, third son of Joseph Godman, of Park Hatch, Surrey, was born in January 1834, and at the age of ten went to Eton, but three years later a very severe attack of what was then called low fever necessitated my removal, and for some years I was unable to work at all. When my health was sufficiently re-established, I received instruction from tutors until I was eighteen years old, when I made a trip to the Mediterranean and Black Sea, visiting Gibraltar, Southern Spain, Athens, and Constantinople *en route*. During the time spent at home I interested myself in Natural History, paying special attention to the British Mosses and Ferns, of which I made a considerable collection. Birds were always a source of delight to me, and I could recognise a large number of British species as well by their flight as by their note.

In 1853 I entered Trinity College, Cambridge, as an undergraduate, and Salvin, in the following year, went to Trinity Hall, of which College he became a scholar; he graduated as a Senior Optime in the Mathematical Tripos and was afterwards made an Honorary Fellow. With similar tastes, it was only natural that we soon met and became fast friends, thus forming that close intimacy which only terminated with Salvin's death on June 1st, 1898. Salvin was a skilful mechanic, and very ingenious in carpentry and cabinet making. Whilst still at Westminster, with the assistance of his elder brother, he built a boat thirty feet long and fitted it with a steam engine, the whole of which, with the exception of the boiler, was made by the two brothers. This boat was launched on the river, and in it they went to a Thames regatta, but, having tested its powers and proved its capability, their object

was achieved, and the boat was finally sold. Some years afterwards, at Dueñas, in Guatemala, when we required specimens of the duck and waterfowl which frequented the neighbouring lake, Salvin again turned his hand to boat building. This time the ribs and frame were made of sticks of green wood cut and fastened together; over this, the hair having previously been removed, a raw ox-hide was drawn, and as the hide shrank, it bound the whole tightly together and made an excellent boat, easily accommodating two people. In this craft we had many sails upon the lake and obtained examples of the birds resorting there.

During our College days, Salvin and I made frequent expeditions together to the fens and other places in the neighbourhood of Cambridge, in order to collect birds' eggs and lepidoptera. On one occasion we heard of a bustard which had been seen in Wicken Fen, and we spent a couple of days searching for it, but with no intention of shooting so rare a visitor. We found both its foot-tracks and some shed feathers, but, as we learned afterwards, the bird had been shot at and probably wounded by one of the fenmen, as it was never seen again. We also spent our leisure hours in Baker's shop, the well known bird stuffer in the Trumpington Road, skinning and setting up birds—an experience which we found of great service to us afterwards when in Central America and on other expeditions.

A good deal of fenland being then undrained, Swallow-tailed butterflies were always to be found, and we collected the larvæ and bred them in Baker's shop. The 'Large Copper' had so recently become extinct, that we searched in vain for it, though Brown, the tailor in Cambridge, who was an ardent British lepidopterist, had a long series in his cabinet, mostly specimens bred from the larvæ he had collected a few years previously.

While still at Cambridge there were several other University men keenly interested in Ornithology, notably the two brothers Newton, Simpson, and my brother Percy, and after our spring rambles we used to meet in each other's rooms and discuss the result of our various expeditions. It was at one of these meetings in 1857 that it was first suggested that some record should be kept of these proceedings, and the idea of establishing a Magazine solely devoted to Ornithology was mooted, but nothing further was done till November 17th in the following year, when a meeting took place in Alfred Newton's rooms in Magdalene College, at which Salvin and myself, Simpson, Wolley, Sclater, Newton, and other ornithologists were present. Before the party broke up it was resolved: "That an Ornithological Union of twenty members should be formed, with the object of establishing a new Journal devoted to Birds: that Lieut.-Colonel H. M. Drummond should be President, Professor Newton the Secretary of the Union, and P. L. Sclater should edit the Journal: that the title of the Journal should be 'The Ibis.'"

The first volume of 'The Ibis' appeared in 1859, and the Magazine has now reached its 56th volume, and the Union has over four hundred and forty members.

In 1857, Salvin made a birds'-nesting expedition with the Rev. H. B. Tristram and Mr. W. H. Simpson (afterwards Huddleston) through Tunisia and Eastern Algeria, in which I was to have joined them, but an accident in the hunting-field laid me up for some weeks and prevented me from accompanying them. The result of this five months' journey forms the subject of two valuable papers, one by Salvin, the other by Tristram, published in the first volume of 'The Ibis.' Later in the year, when I had sufficiently recovered from my accident, I went with my brother Percy to Bodö, in the north of Norway; there we remained for some weeks exploring the surrounding country and were fortunate enough to meet with and secure the eggs of the Great Snipe (*Scolopax gallinago*). Taking the steamer northward to the Alten River, we crossed Lapland on foot to Haparanda, on the Gulf of Bothnia, paying John Wolley a short visit at Muonioniska. Before returning home we visited Stockholm, St. Petersburg, and Nijnei-Novgorod. A short paper on the birds obtained on this journey appeared in 'The Ibis' for 1861.

In the autumn of 1857 Salvin paid his first visit to Central America, in company with Mr. George Ure Skinner, a gentleman well known to both Botanists and Ornithologists through the collections of orchids and birds he had brought from that country on previous expeditions. Salvin undertook the journey, at the request of Messrs. Price & Co., to examine and report upon the nuts of a palm which it was thought might be used in the manufacture of candles. The palm-nuts, however, proved to be useless for practical purposes, and Salvin spent the remainder of his time in travelling through the country and making a collection of birds and insects. He reached Belize, British Honduras, in December 1857, and after spending a few days there, proceeded down the coast to Yzabal and thence by easy stages to Guatemala City, making Dueñas, 30 miles south-west of the capital, his headquarters for six months. Salvin made two excursions to the Pacific coast region and one to the Lake of Atitlan in the 'Altos.' Leaving the country towards the end of June 1858, he returned to England *viâ* San José and Panama. On his return he published a paper in 'The Ibis,' in conjunction with Mr. P. L. Sclater, on the Ornithology of Central America (not including Mexico), in which the authors enumerated 381 birds, all that were then known to inhabit that country.

What he saw, however, on this expedition so whetted his appetite that he returned again to Guatemala in the spring of 1859, with the sole object of studying Natural History. He revisited Dueñas, and collected in the neighbourhood for some months. In October he went to San Gerónimo, Coban, and other places in Vera Paz, returning to Dueñas about the end of the year. In March 1860, he was again in Alta Vera Paz, at Coban, Lanquin, &c., and left for home, *viâ* Belize, in the following month. On this occasion he added very considerably to his collection of birds, as well as insects, and as a result wrote various papers in 'The Ibis' for 1860 on his discoveries.

In August 1861, I joined Salvin on his third expedition to Guatemala, and, after spending three weeks in Jamaica *en route*, we landed at Belize; thence taking our passage in a coasting schooner we arrived at Yzabal on the Golfo Dolce. Here we remained a few days, making preparations for our journey and engaging Indians and mules to transport ourselves and our baggage to the interior. This place will, however, always be associated in my mind with my first sight of a living example of one of the most striking and gorgeous of all butterflies, *Morpho peleides*. I was sitting on the trunk of a fallen tree in the forest, when it came floating past me, but I was so overcome with astonishment and delight at this wonderful vision that, although I had a butterfly net in my hand, I was utterly unable to rise in pursuit until it was too late to capture it.

Crossing the Mico range of mountains, we spent a few days at Quirigua, where I first encountered the great Howling Monkey (*Mycetes villosus*), which frequents the dense forest in troops, making night hideous with its howls, which could be heard in the stillness for a distance of some miles. As we were sleeping in hammocks swung from the boughs of trees, we were somewhat disturbed in our slumbers. We also spent our time photographing the old Indian ruins and exploring the forest in the vicinity. Dry and highly sensitive plates, such as are in ordinary use now, did not then exist, and every photographer was obliged to carry about the necessary materials for preparing and developing his own plates, which might either be wet, entailing immediate development, or dry (tanning), when they could be kept for some days. The whole photographic apparatus, including chemicals, fitted into a case, which formed a load for one of our Indian carriers. Our first essay at photography in the forest was not a success, as we found that after exposing the plates for twenty minutes no details were to be seen. This we discovered was owing to the dense green foliage overhead, through which the light had scarcely any effect in dissolving the nitrate of silver on the plate, and consequently no image was produced. In order to overcome this difficulty, we then hired Indians to cut down the trees which shaded the objects we wished to photograph. This delayed us a few days, which, however, we employed in collecting birds and insects, until a sufficient number of trees were felled to admit light upon the ruins, when we again proceeded to take photographs of the large monoliths, now obtaining very successful results. These ruins are fully described and illustrated in the 'Archæology' of the 'Biologia,' by A. P. Maudslay.

From Quirigua we again took the mule track, for it could hardly be called a road, through the valley of the Motagua River to Zacapa, and thence to Guatemala City. We spent a day or two at the Capital and then proceeded to Dueñas, where we remained for some weeks in most delightful quarters at the house of Mr. William Wyld, a friend of Salvin's. Our time at this place was devoted to collecting, chiefly in the high forests of the Volcan de Fuego, the peak of which we ascended, and

I made a separate expedition to Escuintla in the Pacific Coast region. After our stay at Dueñas we retraced our steps to the Capital, and, crossing the Chuacus Range into the plain of Salama, we took up our abode at the Hacienda of San Gerónimo. Here we resided for some weeks, finding several species of birds and insects which we had not previously obtained. From San Gerónimo we went to Coban, and, after spending some time collecting in the neighbourhood, we visited Cubilguitz and Choctum in the low damp forest of Alta Vera Paz. At Cubilguitz, unfortunately, I contracted a sharp attack of fever, which obliged me to remain for some days at Coban to recruit and prevented my accompanying Salvin on his long and arduous journey on foot to Peten.

When I had recovered sufficiently I returned to San Gerónimo and then went to Buenaventura on the upper waters of the Motagua River, there called the Rio Grande, where I employed Indians to poison some nine miles of the water in order to make a collection of the fish. Before commencing operations I noticed one of the 'mozos' lying flat beside the river, wafting some burning material over the surface of the water, and, upon questioning him, I elicited that he was propitiating the spirit of the river in order that success might attend his efforts and the fish be permitted to die. The method adopted for this purpose was to beat the plant (*Tephrosia toxicaria*, Pers.*, B. C.-Am., Bot. i. p. 258) on the rocks until a froth not unlike soap-suds was formed, this when mixed with the water caused the fish to sicken and come to the surface. At intervals **V**-shaped wicker guides were placed, so that the fish floated down to the point of the **V**, where they were then collected in baskets, and when not otherwise required were used as food by the Indians, who considered them perfectly wholesome. Vast numbers were thus obtained, and from them I made a selection and preserved a good many specimens in spirit (aguardiente), but was somewhat disappointed to find there were but few species represented. On my return to the Capital I journeyed to the Alotepeque silver-mines in company with the manager, and thence to Copan, Honduras, where, after spending a couple of days in examining the interesting ruins, I proceeded *viâ* Zacapa to Yzabal, and there met Salvin on his way back from Belize. Here we again parted, I returning to England, while he started for Dueñas and the interior, passing through the 'Altos,' staying at Totonicapam and Quezaltenango, and making expeditions to the Costa Grande, Retalhuleu, and the lagoons of the Pacific coast at Huamuchal, close to the Mexican frontier. Salvin returned home early in 1863.

During our outward journey to Guatemala in August 1861 Salvin and I passed through the Azorean Archipelago, and I then wished I could stop and explore these islands, but onward we went and soon again lost sight of land. I frequently throughout the voyage recalled these isolated islands and determined, should opportunity occur, that I would explore their fauna and flora at some future date.

* Order Leguminosæ.

It was not, however, till the spring of 1865 that I was able to carry out this project. The careful researches of Wollaston and others had brought to light many interesting forms from Madeira, the Canaries, and Cape Verde Islands; but the Azores had been very imperfectly explored, and it was with the idea of giving a more satisfactory account of the natural history of these islands, and to trace their relationship to the neighbouring Archipelagos, that I decided to investigate their fauna. Oranges from St. Michael's then formed almost the only trade with England, and in connection with the business large numbers of schooners were employed, but with this exception there was no regular, direct communication with England. A small steamer, which carried the mails, left Lisbon once a month for the two nearest groups of islands, but rarely visited the two outer ones. Accompanied by my brother, Captain Temple Godman, I took a passage in this vessel, and shortly after our arrival at St. Michael's we were joined by Mr. Brewer, a well known coleopterist whom I had engaged for the purpose of collecting. Interest in island faunas had been much stimulated by the publication of Darwin's "Geology of the Voyage of the 'Beagle'" and other works on the subject. The question was whether the Azores had in former times formed part of a continent now submerged, as Professor Edward Forbes believed, or whether they had been thrown up from the sea bottom by volcanic agency. After spending four months on the islands, during which time I visited all except Santa Maria, I came to the conclusion that they had always been volcanic islands, and that they derived their fauna and flora from neighbouring lands. In 1870 I published a small octavo book entitled 'The Azores,' enumerating the plants and animals as far as then known, and setting forth my reasons for the conclusion above stated.

The visit to the Azores was followed in 1873 by an expedition to Madeira and the Canaries, in order to compare their respective faunas more critically, but unfortunately the regulations in respect to quarantine were then so stringent that, apart from Madeira, my investigations were limited to the island of Teneriffe. There can, I think, be no doubt that the conclusion I had already formed with regard to the Azores was fully borne out in these islands also.

In the meantime, Salvin was residing at Rotherham, Yorkshire, looking after some ironworks in which he was financially interested; but this was not a congenial employment, and he soon gave it up.

In 1865 he married Caroline, daughter of J. Whitaker Maitland, of Loughton Hall in Essex, and they lived for some years at 23 The Boltons, South Kensington, which became for a time the headquarters of our Museum.

Although both Salvin and I had jointly collected ever since our undergraduate days, it was not until the material was housed at S. Kensington that we really did serious work together; but from thence onwards we spent the greater part of the week in London arranging our collections, publishing papers on them, and attending the meetings of various scientific societies of which we were both members.

Salvin's fourth and last visit * to Guatemala was made in company with his wife, to whose skilful brush we are indebted for the coloured plates of the plants figured in the Botany of the 'Biologia.'

They sailed in a Royal Mail Steamer in April 1873, touching at St. Thomas and Jamaica; then crossing the Isthmus of Panama they reached the City of Guatemala early in June. Proceeding thence to Dueñas, which became their headquarters for some months, Salvin occupied himself in collecting in the forests on the mountain slopes. Together they ascended the crater of the Volcan de Fuego, and a few days later that of Acatenango. Leaving Dueñas for Atitlan they made the ascent of the peak from Santa Lucia on Jan. 17th. Subsequently they visited Mazatenango, the coffee estate of Las Nubes (Cerro Zunil), Quezaltenango, the Lake of Atitlan, Solola, Pantaleon, and San Gerónimo, and after a short stay at the last named place the journey was continued to Coban. Having revisited the Capital they left Guatemala in March 1874. Again crossing the Isthmus of Panama, they sailed for the United States and visited the museums of New York, Boston, Philadelphia, and Washington, and made the acquaintance of the leading scientific people, returning to England on June 4th, 1875.

In the autumn of the same year, Salvin was appointed to the Curatorship of the Strickland Collection of Birds at Cambridge, which necessitated his residence at the University. On his giving up the house in South Kensington in 1873, it had become necessary to find fresh quarters for our museum and library, which now occupied a considerable amount of space, and we took for this purpose a house in Tenterden Street, Hanover Square, to which they were transferred. The building being rather larger than we required, we shared it with some of our ornithological friends, of whom Lord Lilford, Dresser, and Seebohm were among the number. After the evening scientific meetings of the Zoological Society, the offices of which were then in Hanover Square, our rooms became a favourite social resort of ornithologists, and many pleasant and instructive hours were spent there.

During his stay at Cambridge, Salvin came frequently to Tenterden Street and worked at the collections with me, and continued so doing until the death of his father in 1880, when he succeeded to his property at Fernhurst, Sussex, where he afterwards resided, continuing, however, his work in London as before. In the autumn of 1878 we moved our museum and library to 10 Chandos Street, Cavendish Square, and here they remained till after Salvin's death. In 1907 the house at Chandos Street was given up and the library transferred to 45 Pont Street, S.W., while the collections still remaining in our possession were handed over to the British Museum.

In addition to the material obtained during our various visits to Central America and that sent us by the natives we had trained, we found it necessary, for the sake of comparison, to acquire a more thorough knowledge of the South American fauna, and,

* In the notice of his journeys given in the Introduction to the 'Aves' (p. viii) the second expedition, 1859–1860, was not mentioned, and the last visit was incorrectly stated to have been made in 1867.

with that view, employed various expert collectors, whose names are recorded in the body of the work, to visit special localities in Colombia, Ecuador, Peru, Guiana, and other places in South America. We continued to receive consignments from them for several years without having any idea of publishing a connected account of the results, and a very large amount of material, especially amongst the birds and insects, was thus accumulated. It was not till the year 1876 that it was suggested that the 'Biologia' should be undertaken, and three years later (September 1879) the first part appeared.

In the meantime, various collectors were sent by us to Guatemala and other parts of Central America.

Our method of publication was to bring out six quarto parts a year; each part to contain twelve sheets made up of various subjects with six coloured plates, the plates and letterpress so numbered and paged that the parts might ultimately be broken up and bound together in their respective volumes when completed. In this way it was possible to keep several subjects in progress at once, and the plan answered well. We were, however, unable to adhere to the original scheme of completing the work in 60 parts, owing to the ever increasing amount of material received from our collectors—an amount so great that 215 Parts of Zoology alone have been required, the dates of issue extending over a period of 36 years. Even now some families of Insects, the Crustacea, &c., have not been dealt with—though this is chiefly attributable to the fact that no experts on these subjects were available.

On arrival in England, the various consignments were opened, every specimen labelled with its exact locality, and the name of the collector attached. The animals sent were then sorted into their respective orders and families, and as occasion offered, handed over to specialists to be worked out. It was obviously impossible that we could undertake every subject, but the birds and the butterflies we set aside for our own share of the work. The names of the various authors who kindly helped us will be a sufficient indication of our good fortune in securing the services of so many eminent men, all of whom joined the enterprise with great spirit.

In 1886, in company with Mr. H. J. Elwes, I visited Bombay, Simla, Delhi, Benares, Calcutta, and Darjeeling; thence crossing the Rungeet River by a swinging bamboo suspension bridge we entered native Sikkim, collecting plants, birds, and butterflies *en route*. At Darjeeling I purchased a large collection of butterflies, made by Lidderdale, which at the time was considered very representative of the Northern Indian fauna. Starting again from Darjeeling we made a second trip, this time on horse-back, travelling by the Government road constructed by Sir Richard Temple along the Nepaul ridge till we reached Falute (16,000 ft.), and there passed the night in a fairly comfortable bungalow. Next morning we witnessed a magnificent sunrise and obtained splendid views of Mounts Everest and Kinchinjunga rising from the mighty Himalayan range. I also visited Madras and Southern India and Ceylon before returning home.

In the autumn of 1887, having been ordered abroad for the benefit of my health, I decided to visit Mexico, as in working out the Central American fauna, especially the Birds, we found ourselves more deficient in material from that country than from further south. Crossing the Atlantic to New York I took the train to Mexico City, then a six days' journey, entering the Mexican Republic at El Paso (3700 ft.) on the Rio Grande. From this river the land gradually rises and spreads out into the great plateau of Central Northern Mexico, bounded on the east and west respectively by ridges of high mountains covered with pines, and falling abruptly on the east to the Atlantic and on the west to the Pacific. The rainfall being chiefly on the two coasts, the plateau is extremely dry and arid, and the vegetation consists largely of cacti, yuccas, agaves, and mesquite (*Prosopis*), with willows and poplars along the margins of the few water-courses or lagoons. The early part of the journey was passed during the night, but next morning it was evident that a considerably higher elevation had been attained, and on reaching Zacatecas (8000 ft.), a large mining district, the aspect of the country was very desolate and unpromising for natural history purposes, and continued much the same for some distance, but improved a little nearer to the Capital. After spending a few days in Mexico City in making necessary preparations, I was joined by W. B. Richardson, an American bird-collector, and taking him with me started for the Atlantic coast. The first part of the journey, still on the high plateau, was through fields of 'agave' grown for the production of the fermented drink called 'pulque,' so much beloved by the Indians. In about six hours we reached Esperanza, in the State of Puebla, at the Eastern edge of the plateau; here the train enters the wonderful gorge by which it descends to Orizaba, Cordova, Atoyac, and Vera Cruz. The scenery at once changes, the vegetation becoming luxuriant on entering the region of the rainfall.

Before reaching Orizaba we crossed and recrossed the gorge by a series of viaducts amongst palms, tree ferns, and tropical plants, loaded with orchids and tillandsias. At Orizaba we spent a few days collecting, and I was there joined by Mr. and Mrs. H. H. Smith, who went with me as far as Atoyac, where they remained for some time before crossing to the Western side of Mexico. The Smiths had previously been in Brazil, where they made large collections of insects, which are now in the Pittsburg Museum. Mrs. Smith was also skilled in skinning birds which were shot and brought to us by the Indians, and through her we made many additions to our store of ornithological treasures. Leaving the Smiths at Atoyac, a village at the foot of the steep descent from the plateau—still, however, about 1500 feet above the sea and about fifty miles from the coast,—Richardson and I continued our journey to Vera Cruz, the land gradually sloping down to the Atlantic and forming a savanna or plain of sandy ground, sparsely covered with grass and scrub. After spending a few days in collecting, chiefly to the north of the town, we took the mule tram to Jalapa, which being on higher ground reaps the benefit of the rainfall and the vegetation is far more luxuriant. At this

place I engaged Mateo Trujillo, a half-breed Indian, who accompanied me during the greater part of the time I was in Mexico and proved a very skilful collector. He was a first rate climber, and amongst other things made a considerable collection of the frogs, newts, and insects which inhabit epiphytical Bromelias growing on the trees in the neighbourhood of Jalapa. We made an excursion to Misantla and Papantla, on the low ground near the coast at the foot of the mountain range, which proved to be very good collecting ground and added considerably to our birds and insects. On leaving Misantla we returned to Jalapa and over the Cofre de Perote to Esperanza, and thence by train to Mexico City. From the Capital I made two expeditions, the first in company with Mr. Flohr to the pretty town of Cuernavaca, and thence to the caves of Cacahuimilpa, where he hoped to have found some blind insects. The second and also interesting expedition was to Morelia and Lake Patzcuaro, where I added to the collection of Birds, but it was attended with no very valuable results.

On returning to the Capital I next visited Yucatan, crossing the Gulf of Campeche from Vera Cruz to Progreso by steamer, thence to Merida by train, where the railway then ended. My first object was to visit the well known naturalist Dr. Gaumer, who kindly accompanied me to the celebrated ruins of Ticul and Uxmal, a distance from Merida of about forty miles, which journey was performed on horseback. The low forest through which we passed is said to be still frequented by the beautiful 'Pavo real' (*Meleagris ocellata*), but it has become so rare in the neighbourhood that we ourselves did not meet with it. Leaving Yucatan I went back to Mexico City, where I was joined by Mr. and Mrs. Elwes, and together we went to Jalapa, thence riding across the country to Cordova, a most delightful journey of three days, and obtaining magnificent views of the Volcano of Orizaba, with its snow-clad peak. We continued our journey to Puebla and Mexico City, and thence to Amecameca at the foot of the volcanoes Iztaccihuatl and Popocatepetl; the latter we ascended as far as the pine belt, shooting many interesting birds and collecting plants and insects. We left Mexico in the spring of 1888, having been absent from home about five months, and returned to England *viâ* California and New York.

For several years after my return from Mexico, Salvin and I continued diligently to work out the material on hand and the ever increasing amount sent over by our collectors. Salvin's failing health finally obliged him to relax his efforts, and though he still came to London as formerly, he was unable to take the same active part in the work and the difficulty of concentrating his attention on any one subject became increasingly great. He died suddenly at Hawksfold, Fernhurst, Sussex, June 1st, 1898, leaving me alone to complete the 'Biologia.'

The severance of a friendship such as ours had been for forty-four years was a terrible blow to me, for we were more intimately connected than most brothers, and, besides the personal loss, I missed his knowledge and experience in all things connected with our book. At the time of Salvin's death, 141 Parts of Zoology (completing 13 volumes),

the whole of the Botany (5 volumes), and nine Parts of Archæology had been issued: since then 74 Parts (142–215) of Zoology, completing 39 more volumes, and 8 Parts of Archæology have been required, to bring these subjects to a conclusion. It was with a heavy heart that I took up my pen again. With the assistance of Mr. G. C. Champion I continued Vol. II. of the Rhopalocera and finished it in 1901, and in 1904 Vol. III. of the 'Aves' with the help of Dr. R. B. Sharpe, of the British Museum, was also completed.

Salvin had made a special study of the Procellariidæ, a very difficult group of birds, and for a long time we had missed no opportunity of adding specimens of Petrels to our collection. After writing the catalogue of this family for the British Museum, he intended to publish an illustrated monograph on the subject, and for that purpose 40 plates had already been drawn by Keulemans. It remained for me to carry out his intention, and having again sought the aid of Dr. R. B. Sharpe we completed the work in 1910, enumerating 123 species, and illustrating them with 106 coloured plates.

It will be seen that the travels of Salvin and myself covered only a comparatively small part of Mexico and Central America, but we employed a considerable number of expert collectors to travel in districts we had not visited, and they continued to send us the results of their labours for some years after we had left. Amongst them must specially be mentioned W. H. Richardson, Mr. H. H. Smith, and Mateo Trujillo, all of whom accompanied me while I was in Mexico, and Lloyd and Armstrong, who devoted their attention particularly to the Northern provinces of that country.

In working out the Mexican Birds we found ourselves hampered for want of an authentically named collection of North American species for comparison, which did not exist in Europe at that time. In order to remedy this, I acquired the Henshaw collection, numbering 13,326 specimens, and this was rendered still more valuable through the courtesy of the authorities at the United States National Museum, who allowed Mr. Ridgway, the highest authority in America, to go through and verify all the names on the labels attached. I likewise purchased 2500 carefully named birds from Florida from Mr. W. E. D. Scott, 321 named specimens from California, Texas, &c., from Mr. C. K. Worthen, and a series of Mexican birds from Señor F. Ferrari-Perez; and these collections proved of great advantage to us.

In a similar manner we dealt with the insects, &c. I bought H. W. Bates's collection of butterflies, including those he obtained from the Amazons, as well as that of Herbert Druce, containing the 'Kaden' types; the first set of the extensive series of Mexican and Central American Coleoptera amassed by A. Sallé (including the types of several of the older authors, and some thousands of specimens found by himself or by M. Boucard). I also acquired the general collection of Heteromera of F. Bates (22,390 specimens); a portion of Dr. J. S. Baly's collection of Phytophaga; the Janson collection of Elateridæ (25,000 specimens); various Reptilia, Coleoptera, &c.,

collected by A. Forrer in N.W. Mexico and the Tres Marias Islands; a second set of the very large number of Coleoptera obtained by C. T. Höge in his two expeditions to Mexico, the first set now in the Berlin Museum, having been retained by his employer, Mr. Flohr; collections of insects from Messrs. Becker, Biolley, Blancaneaux, Conradt, Gaumer, Janson, Lankester, Morrison, Staudinger, Underwood, Van Patten, Wittkugel, &c. In addition to this material, we had, of course, the whole of that procured by our other collectors, E. Arcé, G. C. Champion, and H. Rogers. Further details are appended on pp. 44, 45.

All the insects from Mexico and Central America, the Sallé and Janson collections of beetles, our own general collections of birds and butterflies, and the Henshaw collection of birds, have been presented by us to the British Museum, and are being gradually incorporated with the National Collection.

The various accessions are enumerated in detail in Vol. II. of the 'History of the Collections contained in the Natural History Departments of the British Museum' (1906) and in the subsequent Annual Reports of that Institution. The first instalment of Neotropical birds (50,120 specimens) was presented in January 1885, and other instalments followed from time to time till the whole of them became the property of the Nation. Amongst the insects, up to 1906, the total number of specimens given in the 'History' is as follows: Coleoptera (85,920), Lepidoptera Rhopalocera (17,829), Lepidoptera Heterocera (12,883), Diptera (17,525), Hymenoptera (10,004), Rhynchota Heteroptera (5543), &c. These figures do not include the Rhynchophora or weevils (22,793), the Staphylinidæ and water-beetles (9474), the Odonata (3000), the Rhynchota Homoptera (5509), the supplementary unworked parasitic Hymenoptera (6293), &c. From 1906 onwards the remaining collections have been handed over to the Museum as soon as the enumeration of the species was completed; that of the Coleoptera was finished in 1911. Our own general collection of butterflies probably included nearly 100,000 specimens, and the beetles alone from Mexico and Central America perhaps double that number. Besides these a considerable number of mammals, reptiles, fish, &c., of which no account was kept, were presented to the National Museum.

F. D. G.

PHYSICAL FEATURES ETC. OF THE AREA TREATED.

The area treated in the 'Biologia' includes the whole of Mexico south of the Rio Grande as far as El Paso, thence to the Gila River, and following it as far as the Gulf of California (but excluding Baja or Lower California). The distant Revillagigedo Islands have been added, owing to certain species of sea birds being common to these islands and the Tres Marias on the western coast of Mexico. Further south we include British Honduras, Guatemala, Salvador, Honduras, Nicaragua, Costa Rica, and Panama, which collectively are spoken of as Central America. The country stretches in a south-easterly direction, having a width in the north of about 1140 statute miles and gradually decreasing till at the Isthmus of Panama it does not exceed 45 miles, and the land only attains an altitude of 300 feet (tierra caliente). In shape Mexico and Central America have been likened to a cornucopia, which collectively they somewhat resemble. Of the physical aspect of each country I propose giving an outline, but as the travels of Salvin and myself covered only a small portion of the area, I shall supplement the account with extracts from other writers; moreover, upwards of fifty years have elapsed since I was in Guatemala, and doubtless great changes have taken place in the interval throughout the whole of Mexico and Central America, partly owing to the extensive destruction of forest for the purpose of cultivation, the construction of railways, and the wanton devastation of large tracts by fire. Thus various places which in our time were good collecting grounds are no longer so, and many species of both animals and plants must either have migrated or become extinct. Earthquakes, too, have done much to alter the configuration of the land, as well as the nature of the vegetation.

The country is divided by the natives into three zones—the 'tierra caliente,' 'tierra templada,' and 'tierra fria' (or hot, temperate, and cold climates respectively). The tierra templada corresponds on an average with an elevation of 3000 to 5000 feet, but the natives of the Mexican State of Vera Cruz draw this imaginary line at a level very different from that used by the people on the western slope of Mexico. For instance, Chilpancingo at 4000 feet in Guerrero has no tropical vegetation and the climate is much cooler than in the State of Orizaba at an almost similar altitude on the eastern slope, which is in every sense subtropical.

The difference is due to the greater rainfall on the Atlantic coast, for the prevailing wind in passing over the ocean is charged with humid air, and when driven by the mountain ranges into a higher and colder elevation, the moisture is then precipitated as rain, thus inducing a much more vigorous vegetation than is found on the Pacific slope.

MEXICO.

The general aspect of the Mexican plateau, as far south as the City of Mexico, has been previously alluded to in the account of my journey there in 1887–1888 (*antea*, pp. 9, 10). On each coast, between the mountain ranges and the sea, there is a comparatively narrow strip of low land, producing a tropical vegetation, which on the Atlantic extends a little to the north of Tampico, where the forests with epiphytical orchids suddenly disappear; while on the Pacific the low land terminates a little above Mazatlan, where the coco-palm ceases to grow, but the vegetation generally is less luxuriant on this coast than on the Atlantic. The plateau itself is arid in consequence of the rainfall being precipitated on the two coastal ranges, and produces but a scanty vegetation, consisting chiefly of Yuccas, Agaves and Cactaceæ, and Mesquite (*Prosopis*). The margins of the few existing streams or pools produce a few scattered willows and poplars, and the whole country presents a desolate appearance. The plateau is indeed a continuation of that of Arizona and New Mexico, and though it is depressed in the valley of the Rio Grande at El Paso, where the railway crosses, it is still at an altitude of 3700 feet above the sea. Southward it mounts considerably higher, and on reaching Zacatecas, the highest point on the railway leading to the Capital, there is an elevation of 8000 feet. The City of Mexico is situated in a valley surrounded by ranges of hills clothed towards their summits with pine trees, and reaching an elevation of about 10,000 feet, while to the south-east are the two lofty volcanoes of Popocatepetl and Ixtaccihuatl, the tops of which reach above the snow limit. Numerous streams descend from the mountains and empty themselves into an alluvial valley with swampy meadows and form several large lakes, of which Texcoco, Chalco, and Xochimilco are the most important. It was on Texcoco that the old Aztec Capital was situated; the houses were built on piles, and the city, which was approached by a causeway, was destroyed by Cortes at the time of the Spanish conquest in 1519–1521. The modern town was placed by the conquerors on the swampy ground about two miles from the eastern margin of the lake, but notwithstanding the altitude it became one of the most unhealthy capitals in the world, for owing to the frequent rising of the level of the lake, the town was constantly inundated. Eventually a great drainage scheme was inaugurated, and for 150 years vast numbers of natives were employed in cutting a huge dyke for the purpose of draining the overflow of the lake; but the sodden ground had become so impregnated with sewage that the mortality was still extremely high, and it was not till 1900 that President Diaz finally completed the extensive drainage system which now renders the city a comparatively healthy resort. There can be but little doubt that in former times one large piece of water covered the whole area of the three lakes, and a map published about 1628 shows Chalco united with Texcoco, when the surface of the two lakes was far greater than it is at present. Owing to the drainage system so recently completed, there are

now several separate lakes draining from one into the other, and finally ending in Lake Texcoco, which is greatly reduced in size; the water of this lake is brackish, while that of the other is fresh.

An account of my journey from Mexico City to Orizaba has been already given (p. 9), so, after stating that I found myself on a limestone formation surrounded by rich vegetation, with the high peak of Citlaltepetl towering above, I will refer to Dr. Gadow for his description of the ascent of this volcano in company with his wife ('Through Southern Mexico,' chap. iii. 1908). He gives in some detail the change of climate at various altitudes, and its consequent influence on the Flora and Fauna, which is of special interest here, as conditions somewhat similar prevail on nearly all high mountains in the tropics.

Starting from Orizaba, Dr. and Mrs. Gadow camped near the village of Xometla at an altitude of 8600 feet, where they remained for a few days exploring the neighbourhood. On their way there they crossed a deep limestone gorge, with fertile vegetation consisting of a species of *Platanus*, magnolias, crotons, and various kinds of oaks, most of these supporting a luxuriant growth of bromelias, ferns, selaginellas, and orchids, interspersed with lichens and tillandsias which proved to be "hotbeds of life." Northward the open slopes were covered with pasture and clusters of trees and shrubs, including mimosas, acacias, yuccas, plane-trees, and bamboos. Here was reached the upper limit of coffee and cotton plantations, while in the damper ravines tree-ferns were plentiful. Higher up, at the level of the central plateau, maize fields became scarce, and tree-ferns and datura disappeared. At this altitude a great change in the vegetation takes place; there is now but little trace of tropical plants, and the climate is temperate, moist and fertile, coinciding with the cloud belt. The vegetation near the camp consisted chiefly of pines, *P. montezumæ* and *P. liophylla*, with open spaces bordered with deciduous and evergreen oaks, arbutus of two species, alder and *Fuchsia microphylla*, with tillandsias in abundance. The larger tillandsias occur up to a level of 9600 feet, where they suddenly disappear, and mistletoe then takes their place on the trees. In the 'barrancas' or gorges are high trees covered with creeping aroids and lianas hanging from the branches with abundance of bamboos and maiden hair fern. Here bird life was almost absent, and only a few tits, a tree-creeper, a woodpecker, and some blue jays were recorded. A few small mammals were not uncommon, and the armadillo, which is fairly plentiful in the lower and tropical country, still exists at an elevation of 8000 feet. Several species of amphibia and reptiles are also found at this altitude, living chiefly in the bromelias and other epiphytical vegetation. They have either no lungs or only tiny vestiges of them, respiration being chiefly carried on through the moist skin. One genus, *Spelerpes*, has a wide distribution in Mexico, and *S. orizabensis*, which leads only a partially arboreal life, ascends to an altitude of 12,500 feet. *Hylodes rhodopis*, which leads the life of a tree-frog, occurs at 10,000 feet, while it also inhabits the

low hot country of Vera Cruz. Snakes of the genus *Crotalus* are common in the neighbourhood of Orizaba, but disappear entirely in the wet and cloudy zone about Xometla, being again represented by a small species with a poor rattle at an elevation of 13,000 feet. Of harmless snakes, only *Tropidonotus scalaris* was met with, a representative of a typically northern genus. A small lizard, *Sceloporus microlepidotus*, also has a great vertical range from the hot plains of Oaxaca to the upper tree limit of Citlaltepetl.

At their highest camp, 12,500 feet, were stunted pines and juniper, while at their feet grew asphodel and tussock grass, which continued to an altitude of nearly 14,000 feet. At 14,400 feet they reached what appeared to be permanent patches of snow, but the white summit of the peak, which from this side they found impracticable of ascent, was still 4000 feet above them.

At a later date Dr. Gadow, however, ascended the peak itself, an elevation of 18,200 feet, approaching it on the north-east side from La Barbara.

Proceeding in a south-easterly direction from Cordova (2700 feet) there was dense tropical vegetation on limestone formation all along the foot of the slopes. Eastward the country showed open savannas, followed by lagoons, swamps, and low forests in the neighbourhood of Agua Fria. The Rio Papaloapan with its many tributaries carries an enormous volume of thick yellow water, and for months the low ground is to a great extent submerged. Further on, Dr. Gadow describes low undulating grazing land, until he reached the railway which crosses the Isthmus of Tehuantepec.

The eastern slope is clad with humid evergreen forests, but farther west the line crosses a ridge at an altitude of rather less than 1000 feet, and passes through dense tropical forests with occasional open patches, but on the Pacific coast a drier type of vegetation prevails. From Salina Cruz and Tehuantepec north-westwards to the City of Oaxaca the land again ascends towards the high plateau. The hills at first are covered with low vegetation, until at 3000 feet pines and oaks appear, but nowhere is there continuous forest. The general character of the country is dry. Deep gorges and sandy river beds alternate with an intricate system of hills and patches of xerophile vegetation. Looking south from an altitude of 5300 feet, the tierra caliente appears to be densely covered with wood, while to the north is seen a flat, almost treeless plateau, with here and there outcropping barren ridges of volcanic nature, or with wooded slopes of Palæozoic formation.

The whole of the Western or Pacific slope is much drier than that of the Atlantic, and the vegetation is consequently less dense. Pine trees descend to about 2000 feet, and cacti prevail.

It was on this occasion that, in company with Mr. Julius Flohr, I made a three days' expedition on mule-back from Mexico City to the Cave of Cacahuimilpa, stopping at the pretty little town of Cuernavaca *en route*, from which a fine view of the western slope is obtained.

The caves, though of considerable size, were on the whole rather disappointing, and the only animals seen were innumerable bats, which tainted the whole atmosphere; as regards other living creatures, even after a diligent search, neither Mr. Flohr nor myself succeeded in discovering any traces of insects. A *Lepisma* and a beetle are, however, reported as having been found by other collectors.

Gadow's account of the Rio Balsas or Mescala basin informs us that it is bordered on the south side, parallel with the Pacific coast, by a long high range of mountains, attaining an altitude of 10,000 feet, densely wooded and intersected by deep gorges, while the river beds, which form the only available roads, occasionally widen into meadows.

At Chilpancingo there is a wind swept, shallow depression of cretaceous formation, surrounded by sparsely wooded hills with meadows on the top of the ridge. To the west the slopes of the Sierra Madre del Sur are covered with rich forest growth: oaks, dwarf palms, and pines abound, higher up oaks, pines, and arbutus, and, finally, pines alone, form dense high forests; while in the gorges, especially within the cloud-belt, most luxuriant undergrowth prevails. Omilteme (7100 feet) where many specimens were obtained, is situated in these mountains.

At Cumbre de Los Cajones, a pass of 3500 feet marks the beginning of volcanic formation. The typical 'tierra caliente,' with an essentially tropical flora and fauna, is found on the southern slope of the main ridge, coinciding with what is officially known as La Costa. The upper limit may be put at 1000 feet, but the country loses its tropical character on the ridges, which rise higher than 1500 feet.

From Coquillo to Chacalapan (700 feet) there is tropical life, and from thence to the coast across lower ridges, the subsoil consists of gneiss and granite in rapid decomposition, while wooded ground and open pastures are also found. The rivers during the winter season are frequently dry, but near the granite bound coast are lagoons mostly containing pure water; a broad belt of almost impenetrably high forest extends in places to the sea. Mangrove swamps are permanent features of the landscape, but in the rainy season many parts of the forests are inundated, and over nearly the whole of the coastal district a dense mass of tall herbs usurps the place of brushwood in the forest belts.

Throughout the State of Guerrero large collections, chiefly consisting of birds and insects, were made for us by Mr. and Mrs. H. H. Smith, who spent a considerable time in the district, paying special attention to the fauna during the time I employed them in Mexico.

We have no detailed account of the States of Durango, Sinaloa, and Sonora, but the general aspect is barren and rocky, and although I sent one or two collectors to those districts, I gained no accurate information as to the physical features.

REVILLAGIGEDO ISLANDS.

Neither Salvin nor I were able to visit these islands, and the only information respecting the physical features and distribution of the avifauna is from the account given by Mr. A. W. Anthony in the 'Auk,' xv. pp. 311–318, after his visit in 1897.

The Revillagigedo Islands lie to the S.W. of Cape San Lucas, Lower California, and consist of a group of four islands, at some considerable distance apart, but all are of volcanic origin and in general appearance extremely rough and broken. Socorro, the largest of the group, is about 240 miles south-west of Cape San Lucas and about 285 miles to the westward of Maria Madre, the largest island in the Tres Marias group, off San Blas. It is estimated to be about one hundred square miles in extent, and rises to a height of 4000 ft. in the centre, where there is an extinct volcano. The greater part of the island is covered with a dense mass of undergrowth which it is almost impossible to penetrate, especially on the north and north-west, or weather side. Trees are abundant there, but do not exceed forty or fifty feet in height, though usually covering a considerable area with their spreading branches. On the south and east the trees are mostly confined to the cañons, where they are smaller than on the northern slope.

Clarion Island lies approximately about 200 miles westward of Socorro and somewhat further south, and has little in common with the other islands, either in fauna or flora. Its length is about five miles, and width one mile, the ground rising about 1500 feet above the sea. A few low trees or shrubs, the largest not over ten feet in height, are scattered along the main plateau, and in a few places extend to the level ground on the south side, which lies between the Mesa and the coast. Nearly the whole of this flat ground is covered with a dense growth of cactus (*Platopuntia*), over which has grown a mass of vines, and a passage through this belt can only be made by the diligent use of a bush knife. At a short distance from the beach were found two small shallow ponds, which contain water during the rainy season only, but as the high tides evidently overflow the barriers and flood them with sea water, it is doubtful if they are ever otherwise than brackish. At the time of Mr. Anthony's visit, the ponds had been dry for some months, and no water was found upon the island.

As might be expected from the position and vegetation of Clarion, the birds were quite different from those on Socorro and San Benedicte. The only land bird common to any two islands was the Raven, but on Socorro it was not seen.

San Benedicte is a small island about three miles in length with an average width of half a mile, and lies 35 miles north of Socorro. There is little vegetation, but wherever sufficient soil is found, there is a heavy crop of coarse grass growing five or six feet in height, and rendering progress extremely difficult. The barbed seeds

penetrate a man's clothing, and were found to be even more unpleasant than the cactus thickets on Clarion Island.

Roca Partida, or Divided Rock, lies 65 miles north-west of Clarion, and is the fourth of the group. It is of considerable elevation and has the appearance of a ship under sail.

The number of species of birds observed by Mr. Anthony are as follows:—Socorro (24—13 of which were generally distributed land birds), Clarion (17—10 of which were land birds), San Benedicte (11—including 3 land birds).

TRES MARIAS ISLANDS.

As in the case of the Revillagigedo Group, neither Salvin nor I visited the Tres Marias Islands; but Alphonse Forrer collected in Maria Madre on our behalf and obtained a large number of specimens. For a description of the physical aspect of the islands we are indebted to Mr. E. W. Nelson, who wrote a 'General Account of the Tres Marias Islands with Reports on Mammals and Birds,' supplemented by Notes by other authors on the Reptiles, Crustacea, and Plants (North American Fauna, No. 14, 1899).

The islands are situated about 65 miles off the west coast of Mexico from San Blas, between lat. 21° and 22° and long. 106°–107°, and consist of a group comprising Maria Madre, Maria Magdalena, Maria Cleofa, and San Juanito, arranged in a north-westerly and south-easterly direction.

About 20 miles from the mainland lies the small island of Isabel, about 1 mile long and 150 feet high. It chiefly consists of the remains of an old volcano, and a small crater still occupies the centre. There is evidence of its having once been a much larger island, though now apparently sinking. The soundings in the channel between the islands and the mainland gradually deepen to nearly 300 fathoms, but west of the group the sea bottom falls rapidly to over 1500 fathoms.

Maria Madre, the largest island, measures 8 by 15 miles, and rises over 2000 feet above the sea. The interior is occupied by a mountain ridge extending almost the whole of its length, but descending to a gently sloping area at each end. The eastern side has the longer slope, while the western or seaward face is much more abrupt, thus corresponding with the formation of the mountains parallel to the coast on the adjacent mainland. Both slopes are scored at intervals with cañons, which usually descend in a nearly direct line to the sea, and along the lower slopes of which, Spanish cedars and wild figs are grown, certain trees attaining a great size. Generally speaking, the forest is low and scrubby near the shore, but increases in luxuriance farther up the slopes. In its primeval condition before the advent of wood cutters, a fine example of typical forest growth must have been presented here.

North of Maria Madre, and separated by a channel 4 miles wide and 5 or 6 fathoms

deep, is an islet 3 or 4 miles in diameter and only about 100 feet high; there is a narrow border of buffs along the northern shore, thus forming an exception to the other islands, which are mountainous and rise in successive slopes to the culminating point near the centre. Here the vegetation largely consists of bush and scrubby trees 8 to 15 feet high, with many agaves on the sandy southern end.

South-east of Maria Madre, and separated by a shallow channel 8 miles wide, is Maria Magdalena, roughly triangular in outline, and 7 or 8 miles across, rising in the centre to an altitude of about 1500 feet; south-east again lies Maria Cleofa, the last of the group. In shape it is irregularly rounded, and about 3 miles in diameter; the altitude is apparently much less than 1320 feet, as recorded on the charts. The channel between the two last named islands is about 12 miles wide and much deeper than the others. Maria Magdalena and Maria Cleofa have a central mountainous elevation from which cañons descend in all directions to the sea.

The north-eastern points of both islands are low, flat, sandy areas of limited extent, while the western faces are rocky and precipitous. Permanent fresh water is very scarce on all the islands.

When visited near the end of the long dry season in May 1897, most of the herbaceous plants were withered. The general appearance of the vegetation was, however, the same as in similar situations on the mainland. The most noticeable plants were Spanish cedar (*Cedrela*), 3 species of wild fig, 2 of *Pithecolobium*, 5 of *Solanum*, 2 of *Ipomœa*, a *Passiflora*, Cassias, Euphorbias, a large *Agave*, a large *Cereus*, and 2 Opuntias.

The following is a summary of the species of animals and plants known from the Tres Marias in 1897, as quoted by Mr. Nelson:—Land mammals, 11 (7 peculiar); birds, 83 (24 peculiar); reptiles, 18 (1 peculiar); freshwater fish, 2; freshwater shrimp, 1; land molluscs, 6; plants, 136 (12 peculiar). Two species of bats found by Forrer were not met with by Mr. Nelson, and he was of opinion that both were stragglers from the mainland.

The relative situation of this group of islands, all with narrow, shallow channels between them, shows conclusively that at one time they formed a single island at least 45 or 50 miles long, and at a still earlier stage they must have been connected with the mainland. One of the strongest proofs of this former connection is shown by the correspondence between the fauna and flora. The breaking down of the original island into several smaller ones and the continuous encroachment of the sea appear to indicate that the subsidence is still in progress. The mainland in Tepic near the coast was within a comparatively recent period the scene of great volcanic activity, and the Tres Marias Islands bear evidence of having undergone various oscillations, while the marine deposits of Maria Madre are further indications of the recent change.

YUCATAN.

During my stay in Mexico in 1887–1888, I determined to visit the province of Yucatan with the object of exploring the wonderful ruins of Chichen Itza. Taking my passage in a steamer from Vera Cruz, I landed at Progreso, a port of Yucatan situated on a spit of sand separated from the mainland by marshy swamps, which, during the stormy northers that prevail in winter, is occasionally inundated.

After spending a day or two at Merida, the capital, I visited Dr. Gaumer at Izamal about fourteen leagues distant. This American gentleman, long resident in the country, had made considerable collections of birds and insects, some of which he had previously forwarded to us in England.

My original intention had been to ask him to accompany me to Chichen Itza, but, owing to the disturbed state of the Indians in the vicinity, he advised me not to attempt the journey, volunteering instead to go with me to Ticul and Uxmal, a journey we performed on horseback. On leaving Merida we passed through a forest with patches of open ground, some of which were cultivated with Indian corn and an agave, from which a fibre called 'sisal' is obtained and exported in large quantities. The name 'sisal' is derived from an old port on the north coast, six leagues from Progreso, from whence the fibre was originally shipped. As we proceeded further south, the forest trees became larger, but still not of the great size usually found in the tropics. The ruins of both Uxmal and Ticul have been very much despoiled, a vast number of the stones having been carried away for building purposes, while many of the carved pieces formed part of the 'hacienda' at which we resided. From a detailed account of these ruins when described by Mr. A. P. Maudslay in the 'Archæology' of the 'Biologia,' it is evident that they were enormously reduced in size since the visit in 1839 of J. L. Stephens, who published in 1843 an account of them in his 'Incidents of Travel in Yucatan,' with admirable illustrations by Catherwood.

The peninsula of Yucatan is flat and of a recent limestone formation; there is a low range of hills which stretches from a point a few miles south of Merida to the neighbourhood of Peto some distance south of Ticul, but nowhere exceeding 500 feet in height.

The coast is very low and swampy, while further inland are forests, which in a few cases have been cleared, but the whole country is very sparsely inhabited. The southern part is, so far as I could learn, but little known, but it is said to be largely covered with forest and the trees are much finer than those in the north.

The following description of the country is mainly taken from Dr. Gaumer's notes published in Boucard's account of a 'Collection of Birds from Yucatan' (P. Z. S. 1883, pp. 434–439), supplemented by my own observations in 1887–1888. At Tizimin the country, like the rest of Northern Yucatan, is on a low level, but to the north east and south lie vast forests, for the most part uninhabited since the migration of the Indians

half a century ago. This region is filled with ruins both ancient and modern, but of the former very few of any size remain. Some of the ranchos have, however, been re-peopled and most of the birds have been obtained in the vicinity of the clearings. At Yok Jonat Ku there is a large forest where the trees are high and the ground comparatively open ; here the magnificent turkey *Meleagris ocellata* is still to be found. At one time this bird was distributed all over the peninsula, but owing to the depredations of the Indians, who esteem it highly as an article of food, it is now almost exterminated.

Lagartos is a sea-port town at the mouth of the river, or more properly an arm of the sea bearing the same name, and innumerable streams or—as Dr. Gaumer believed—subterranean rivers find an outlet there. The waters are very salt, and in the dry season are even more saline than the sea itself. This so-called river is broad and shallow, bordered by a dense growth of low bush, behind which lie marshes of salt or brackish water, and here in June and July thousands of flamingoes in their finest plumage were seen by Dr. Gaumer, while swarms of other sea-birds were always in sight. The innumerable hosts of mosquitoes which come with the first rain impeded the work here, and the intermittent and pernicious fevers render collecting both difficult and dangerous. The country generally has no surface water, and the only supply is from the Aguadas and Cenotes (Senotes or Jonats), as they are called by the natives. Fortunately the Aguadas, which are said to be of natural formation, but which appear to have been reconstructed by the ancient Indian races, are very numerous ; they consist of a deep excavation in the earth, sometimes circular in form, but giving the idea of having been at one time quadrilateral, and from fifty to one hundred feet in diameter. They contain water all the year round, though never of any great depth. The sides being inclined, they form natural drinking places and are much frequented by animals and birds—so much so, that the collector usually obtains a good number of specimens in the vicinity.

The Cenotes are probably natural openings in the earth with steep walls of limestone frequently sixty feet high ; they vary in size and shape, but always contain clear, fresh water. They are believed to be openings to underground rivers, and are frequently found in immense caves with a narrow circular mouth ; at the water's edge there is no resting-place and no approach except by the steep sides. Vultures, owls, and similar birds nest in the walls. The caves are also frequented by swallows, bats, and motmots, and reptiles are said to occur in immense numbers. The water contains numerous fish belonging to the Siluridæ, and in the shallow open water-holes near the coast there is said to be another species belonging to the same group, but Dr. Gaumer was, unfortunately, unable to capture a specimen. The distribution of these Siluridæ confirms the belief that underground rivers in Yucatan do exist.

A very interesting description of the climate (in 1878–1879) is given by Dr. Gaumer *,

* See Boucard, P. Z. S. 1883, pp. 434–462.

who first reached the country in the middle of October 1878. The summer rains had ceased about ten days previously and the weather had been good, but throughout October, November, and December 'norther' followed 'norther' every ten to fourteen days, accompanied by light drizzling rain which lasted generally from two to four days with increasing cold. In January there were four moderately heavy rainfalls with strong 'northers' and cold nights. In February there were five 'northers' and one with very heavy rainfall accompanied by hailstones of such size that they were quickly gathered up and by many people placed in bottles thinking that they might so be preserved. From February 26th to May 23rd no rain fell and the sky was cloudless for weeks at a time. The heat during the day gradually increased, until in April and May it was almost intolerable, and on account of the dry air and clear sky the radiation was so great that the nights were disagreeably cool, though generally so balmy and pleasant. The birds disappeared as the dry season advanced, when only a few common resident species round the ranchos and Aguadas were to be found. On May 23rd the first summer rains commenced and were followed by daily showers at mid-day. All nature changed as if by magic, new leaves grew, and the forests were again populated with songsters. In June the rains began at 11 A.M. and ceased at 2 P.M. with an almost daily regularity. In July they began at 10 A.M. and ceased at 3 or 4 P.M., but never earlier. In August it rained from 10 A.M. till nightfall and sometimes later. During these last three months there were from five to eight days in each month upon which no rain fell. The heat was almost insupportable, even to the natives, and yellow fever raged in the towns of the interior. In September the rains lasted from 8 or 9 A.M. till midnight and not infrequently all night, but the weather became milder. Reptiles were almost the only things to be found. In October 1879, during the first twenty-seven days, rain fell in torrents and almost incessantly, the sun was seen but on four or five days and the stars appeared in patches on five nights only, and not five consecutive hours were fine during those twenty-seven days. Yellow fever gave place to bilious fever. Insects were rarely seen, birds almost entirely disappeared, and any skins were worthless, as either owing to the heavy rain or to some other cause the feathers had not yet commenced to grow.

An account of Yucatan would scarcely be complete without some particulars of the distribution of species and a comparison with that of the islands off the coast and in the Bay of Honduras, which were visited on our behalf by Dr. Gaumer. In a summary of the island-birds examined in detail by Salvin ('Ibis,' 1890, pp. 84–95) he arrives at the conclusion that they split up naturally into three groups. Leaving out Meco, the exact position of which is uncertain, he considers that those from Holbox and Mugeres may be classed together, Cozumel by itself, and Ruatan and Bonaca (Guanaja) by themselves, though all show a strong affinity to the birds of the mainland. The two last named islands are stated to be very different in their physical features to the others mentioned; they are of high altitude and attain an elevation of 1200 feet, and

have the upper parts covered with pines, in contrast to the low ground and recent coral-limestone formation of the remainder.

The total number of species obtained was 214, of which 79 are migrants from North America, and of the remaining 135 species, 27 are birds which frequent the sea coast. The table of distribution of the 108 non-migrating species shows that the affinities of the birds of these islands as a whole are largely on the side of those on the mainland, the West Indian element being very slight. Northern Yucatan and the islands adjoining are separated from Cuba by a depth of over 1000 fathoms, and the Bay Islands from Jamaica by over 500 fathoms. Had there been any recent land connection, a supposition which the similarity of the birds alone would justify, the mainland as well as the West Indies would hardly fail to show such a connection in a much more pronounced manner, and we should not find the strong contrast which exists between the faunas of Cuba, Jamaica, and the mainland, but a larger number of features in common; this contrast is still more marked in the Lepidoptera Rhopalocera.

The alternative supposition to account for the West Indian element in these islands is that the birds have reached them at no distant date by flight. When we consider that the trade wind blows in the direction of Yucatan and this coast for several months in the year, it is scarcely a matter of wonder that some West Indian birds stray so far west. Cozumel appears to have been separated from the mainland for a considerable period, during which time it has received casual immigrants from the West Indies, from North America, and from the mainland, some at a distance of time sufficient to allow of their modification. There are 159 species of birds, 65 of which are migrants and 27 of very wide range.

My stay in Yucatan was very short, and owing to the state of my health, which rendered me unfit for much exertion in a country so little explored, I was able to do very little collecting. The specimens acquired, however, were, as before, mostly due to the enterprise of Dr. Gaumer, who employed natives to collect, but they were necessarily from a limited area. My trip ended very much as it began, for I was obliged to return to Progreso, and from thence by steamer to Vera Cruz.

BRITISH HONDURAS.

British Honduras, or the colony of Belize, as it is often called, situated on the south-eastern shore of the peninsula of Yucatan, is about 160 miles from north to south and 60 at the widest part. The navigation of the coast is both difficult and dangerous, on account of the numerous cays and coral reefs with which it is bordered. In the neighbourhood of the town of Belize, and for some distance inland, the ground is low and swampy and thickly clothed with mangroves and tropical jungle. Further west there is a narrow belt of alluvial soil, beyond which, and parallel to the coast, are tracts of arid sandy land called 'pine ridges,' from the pine trees with which they

are covered. Still further inland are the 'Cahoon Ridges,' clothed with palm trees, while beyond are broad savannas studded with clumps of trees and intersected with streams. The Manatee Hills rise in a further succession of ridges parallel to the coast, and are from 800 to 1000 feet in height, while to the south the Coxcomb Mountains attain an altitude of 4000 feet; further inland there are said to be a succession of valleys and hills at altitudes varying from 1200 to over 3000 feet above sea-level, but this part is very imperfectly known. The climate near the coast is generally hot and damp, but tempered by the trade winds, and though the annual rainfall is said to be about 100 inches, the country is tolerably healthy. Unlike the rest of Central America, British Honduras is not subject to earthquakes; it appears to be entirely outside the volcanic area, which otherwise extends from Mexico to Western South America.

In 1862 Salvin, as stated on p. 5, went from Coban by way of Peten, down the Belize River to the town of Belize on the coast, but unfortunately he left no details of the country through which he passed. His intention was to proceed direct to Yzabal, and thence back to the interior of Guatemala, but finding no vessel ready to sail, he hired a schooner and occupied the time in exploring some of the numerous atolls and coral-reefs which line the coast, and later published an interesting account of this expedition in 'The Ibis' for 1864. He described the Barrier Reef as extending from Ambergis Cay to Ranguana Cay, its most northerly point; this last cay is twenty-five miles from the coast, so that the reef, instead of running more or less parallel with it, forms an angle enclosing a long lagoon, which, as well as the reef, is studded with numerous cays. Nearly due east of the town of Belize, outside the Barrier Reef, and separated from it by a deep channel, lies the Atoll of Turneff, within which several lagoons are included. Fifteen miles eastward of Turneff lies another atoll, called Lighthouse Reef, on the eastern margin of which are four cays—Long Cay, Middle Cay, South-West Cay, and South-West-of-All Cay; the remainder of the reef consists of a line of breakers, showing here and there a stranded log or a protruding spit of sand. It will be easily understood that these reefs, many of which are covered with mangroves and coco-nut palms, form an ideal place for sea-birds, and as Salvin's visit took place at the height of the breeding season, he procured a large number which he had not previously obtained.

In addition to these sea-birds, Salvin mentions two humming-birds, two tyrants, a warbler, a mocking-bird, an osprey, an ibis, egrets, etc. The paper quoted is too long to reprint in detail, but it is still the only account known to me describing the cays in question. His subsequent visit to the lagoons on the Pacific Coast of Guatemala in 1863 is referred to under the heading for that country.

HONDURAS.

The Republic of Honduras is bounded by the Bay of that name and the Caribbean Sea on the north, by Guatemala on the west, and Salvador, the Pacific Ocean, and Nicaragua on the south; it includes the islands of Ruatan, Bonaca (Guanaja), and the islands adjacent. The general aspect of the country is mountainous, and it is traversed by ranges and hills radiating from the base of the Cordillera. The main chain, which does not approach within 50 or 60 miles of the Pacific, is not an unbroken one, as it turns back and forms basins or valleys, within which are collected the head-waters of the streams which flow in the direction of the Atlantic Ocean. Viewed from the Pacific, the mountains present the appearance of a great natural wall, with a lower range bristling with volcanic peaks between it and the Western Ocean. The Cordillera proper forms an irregular line from north-west to south-east, interrupted, however, by the great transverse depression of Comayagua, which extends about 40 miles to the north with a width of from 5 to 15 miles, and contains the Humuya River, which discharges its waters into the Atlantic; while to the south it forms the valley of the Goascoran River, which flows into the Pacific. The whole country has a great diversity of surface and elevation, with fertile valleys and high plains, affording every variety of climate.

Some notes on the aspect of this country were published in 'The Ibis' for 1860 by G. Cavendish Taylor. He crossed from the Pacific to the Atlantic Coast, and many of the places described have been mentioned in the 'Aves' section of this work. Arriving in December 1857, from Panama, at La Union, Salvador, he crossed to the island of Tigre, and thence to La Brea in the Gulf of Fonseca, which is studded with densely wooded volcanic islands. Tigre abounds with scorpions and large hairy spiders, and many birds were obtained near an old crater, now a lagoon full of reeds and floating grass. Mr. Taylor visited Aremecina, Caridad, San Juan, and Lamani, and so over the tolerably level plain mostly covered with forests to Comayagua. In the vicinity of the town were cactus bushes on one side, dense jungle intersected by rivers and woods on the other, and high mountains bounding the plain. Continuing his journey towards the Atlantic, Siquatepeque was reached by a route crossing the top of the mountains at an elevation of 5000 feet—here again was open plain, 3600 feet above sea-level, and surrounded by mountains; then after passing over undulating ground covered with pine trees, giving it a park like appearance, he arrived at Taulevi. Here arrangements had to be made for the journey through the dense forests to the Lake of Yojoa, some three leagues distant. Men had to be sent forward to clear a path and engage boats for the passage down the lake. The route lay at first by open

savannas and wooded hollows, but soon a broad, rapid stream was crossed, and entrance was made into the dense forest, through which a road had to be cut, but further on the trees were lofty with huge buttresses at the base, and the undergrowth was not very thick. It was nearly dark when the river, flowing from the lake, was reached and the canoes launched. The current was slight, the water deep and still, and the banks were covered with high trees and dense forests, every bush and bough was alive with fire-flies, and the cries of night-hawks, coupled with the croaking of innumerable frogs, made no inconsiderable noise. The wind was ahead and occasionally so strong that the travellers were unable to proceed until it lulled, but at dawn they had completed twelve miles and had reached their destination. Two days were spent at Agua Azul, so called from the colour of the deep spring which rises near the 'hacienda' and flows into the lake. Numerous interesting birds were seen among the reeds and alligators (*Crocodilus americanus*) were not uncommon, while every tree and blade of grass swarmed with 'garrapatas.' Leaving the lake, which was surrounded by high mountains, the journey was made principally over savannas and open ground to the town of Yojoa, and *viâ* Potrerillos to the Atlantic. In the forest the route lay for miles through vistas of palm trees and bamboos, which shaded the path with their feathery branches, but unfortunately prevented the deep mud-holes from drying up. After leaving San Pedro, where brown monkeys with white faces were seen, a high range of mountains was crossed and Omoa reached on February 14th.

G. C. Taylor enumerates one hundred species of birds, and G. M. Whitely subsequently sent us a collection of 135 species from the same country. These were named by Salvin and a list of them published in the 'Proceedings of the Zoological Society' for 1870, pp. 835–839. Whitely's skins (520) were obtained in 1869 in the vicinity of Puerto Caballo (Cortes)*, Julian, Medina, and San Pedro. The three last named places are situated in the low forest-lands on the Chamelicon River; San Pedro, the farthest inland, is not more than 30 miles from Puerto Caballo, now the Atlantic terminus of an incompleted inter-oceanic railway.

After examining the collection carefully, it became apparent that the Ornithology of this part of Honduras scarcely differs from that of the thoroughly explored lowlands of Vera Paz.

GUATEMALA.

Guatemala is coterminous on the north and west with Mexico, the flat low lying peninsula of Yucatan extends to the north-east, British Honduras, the Caribbean Sea, and the Republics of Honduras and Salvador are on the east and south-east, while on the south-west lies the Pacific Ocean. The greater part of the country is

* Often confused with Puerto Cabello in Venezuela.

mountainous, the main chain of the Cordillera forms the watershed, and at a mean elevation of 7000 feet runs nearly parallel to the Pacific coast at a distance of about fifty miles from it. The steep slope on the Pacific side is broken by many volcanoes, while towards the Atlantic the land sinks in a gentle incline with subsidiary ranges extending nearly to the water's edge. Of the volcanoes several are active, the most noted is the Fuego (14,070 feet) with its twin sister the Agua, so called because in 1541 a lake, which occupied the centre of the crater, was discharged by a great eruption on to the former capital below and the city now called Ciudad Vieja was completely destroyed by water. Both volcanoes are clothed with dense forests from about 7500 feet to 10,000 feet, above which level there are scattered pines for 1000 feet or more, of which stunted examples are even to be found in the extinct crater of the Agua. Below 7000 feet the forest has been cleared for cultivation, and only parts are now clothed with a dense growth of scrub. The chief rivers are the Usumacinta, which flows into the Gulf of Mexico, and the Motagua and Polochic, which fall into the Bay of Honduras. Those flowing into the Pacific Ocean are short and rapid, as the fall from the Cordillera is very steep.

The so-called 'coast country,' however, extends a long way inland, as during the wet season the torrents which descend from the Cordillera are charged with volcanic sand and disintegrated scoriæ, and when discharged into the ocean they are cast back by the waves and the deposit forms a line of sand-bank. The constant heaping up of this bank often closes the mouths of the smaller streams during the dry season, and when the current is not sufficient to reduce the sand-bar the water expands inside the beach, forming lagoons and marshes along the whole coast. These lagoons are a favourite resort for waders and sea-birds, of which Salvin later obtained a large number, as well as a considerable quantity of fish.

As previously mentioned, Salvin made no less than four expeditions to Guatemala, but I will only describe the physical aspect of the country we travelled over together, alluding, however, to those parts which he visited alone and giving extracts from some of his scattered papers published in 'The Ibis' and other magazines. We landed in September 1861 at Yzabal, on the Golfo Dulce, and after a short stay we proceeded towards the Capital. The neighbourhood of Lake Yzabal is covered with dense forest extending beyond the Mico Mountains, which we crossed into the Motagua Valley in order to reach Quirigua. Here we spent a few days, and then proceeded up the river valley to Zacapa by mule path, the country gradually becoming drier and the vegetation more arid; cacti and thorny shrubs became abundant, taking the place of more luxuriant plants. Indian settlements were found at intervals of every few miles, where the brushwood had been cleared for the cultivation of maize and coffee-trees, which were growing in small patches. Much the same character of dry country prevailed throughout the journey to Guatemala City, which is situated on

the Cordillera at an altitude of about 4500 feet above the sea. From the Capital we visited Dueñas, a village on the Pacific slope situated in a plain at the foot of the Volcan de Fuego and between it and the Volcan de Agua. Here we spent about three months, exploring the country and making frequent excursions into the forest of the Volcan Fuego, which furnished a great contrast to that near the coast; the high trees were the only corresponding feature, but both vegetation and climate were entirely different. Instead of the incessant noise of the buzzing of myriads of insects, life seemed almost extinct and a dead silence reigned throughout, broken only by an occasional gust of wind or the fall of some rotten tree. The mountain itself is furrowed with deep ravines, called 'barrancas,' the sides of which are exceedingly steep and quite impassable, and in ascending the mountain, care must be taken to keep on the top of the ridges between them. The forest shuts out the view of the surrounding country, consequently landmarks are not available, and as one ravine almost exactly resembles another it is an extremely easy matter to lose one's way by inadvertently following the edge of a new 'barranca.' The lower part of the forest up to about 7000 feet has been cleared for cultivation, but quickly reverts to a dense growth of scrub, above which is found a belt of evergreen-oaks followed by deciduous trees of various species, amongst which the remarkable *Cheirostemon platanoides* mingles in the highest range with alders. Then follows more open ground with pine trees and coarse grass, but the trees become stunted as the ascent increases, and finally disappear at an elevation of about 11,000 feet. From thence to the summit of the Fuego the cone is composed of cinders and ashes interspersed with short coarse grass. The mountain is divided into two peaks or cones near the summit, connected by a narrow ridge of cinders, the southern and higher peak is still active, and from it a perpetual column of thin smoke is always plainly visible. This cone is very steep, and the climb to the edge of the crater itself is exceedingly laborious, as the foot sinks at each step deep into the ashes. The view, however, from the point well repays the trouble of the ascent. Southward the eye travels a distance of 50 miles to the coast, far beyond again is seen in dim outline the horizon of the Pacific Ocean, while below on the other side lies the deep abyss of the crater itself. The northern cone is more or less covered with coarse grass extending to the summit, while the interior of the crater has been almost filled with the eruptions of the more recent southern volcano; but signs of internal fires are not wanting, as jets of steam and sulphurous vapour are still seen issuing from the fissures in the rocks. In one of the hotter crevices I found a vigorous plant of *Lycopodium clavatum* and a *Selaginella* taking advantage of the warmth and moisture and growing with wonderful luxuriance at an altitude of nearly 14,000 feet. The descent was by no means easy, as there was no track to mark our way, but we had fortunately taken the precaution of slashing the trees with our big knives or 'machetes' on our way up, which indicated our

route sufficiently to enable us to return to camp in safety. The Volcan de Agua is very similar to the Fuego, though somewhat less in height, but there is a fairly good mule track nearly to the summit. This track is frequented by the Indians, who ascend the mountain for the purpose of charcoal-burning and also in search of ice, which they found in the old crater in sufficient quantity to supply the needs of the Capital at that time.

Having made considerable collections, we returned to Guatemala City and, recrossing the Motagua River and the Chuacus Range of mountains, took up our abode at San Gerónimo, a sugar-cane plantation in the plain of Salama, in Baja Vera Paz. The surrounding mountains are clothed with forest composed of various trees, including pines. The plain itself is arid, except when irrigated for cultivation, as at the Hacienda of San Gerónimo. We next proceeded to Coban through the district north of the plain of Salama. The road soon leaves the plain, and the broken country is covered with scrub and forest, the rainfall being much greater as one approaches Coban than on the Pacific side of the Cordillera. During the rainy season there is usually a severe thunderstorm in the afternoon, followed by a clear sky, but during the dry season little or no rain falls and vegetation suffers greatly. In Alta Vera Paz and towards the Atlantic rain apparently falls at all seasons and all hours, and vegetation is consequently much more abundant.

At Tactic, a forest district near the head of the Polochic River, our porters failed to arrive, and we were forced to spend the night without our baggage. It was so bitterly cold that in the morning the ground and even the backs of our mules were covered with hoar-frost. A few days later, on our return journey, the effects of the unprecedently low temperature were plainly visible on the vegetation around. On reaching Coban we found a large Indian village where the inhabitants were born collectors, and very soon they brought in, in almost embarassing numbers, specimens of birds, frogs, toads, lizards, snakes, and insects of all kinds. The natives there were specially expert in the use of the blow-pipe, with which they killed most of the smaller birds. The weapon consisted of a straight piece of hollow wood about eight feet long, and the projectile, a hardened pellet of clay, fitted closely into the groove of the pipe and was blown from the mouth by the marksman. In this way a large number of birds was obtained with little or no damage to the plumage. Such was the accuracy of aim that, even at a distance of from 15 to 20 yards, many humming-birds were killed.

After some weeks spent in collecting at Coban we visited Cubilguitz and Choctum in the low damp forest of Alta Vera Paz, thence travelling towards Salinas in the humid valley of the Chixoy or Rio de la Pasion, a tributary of the Usumacinta River. The roads or tracks made by the natives were extremely bad in this locality, the ground very broken, and the soil a stiff clay, so slippery in places that it was scarcely

possible for animals to keep their footing. As there were no villages whence food could be obtained in this little known district, it was necessary to take a three weeks' supply from Coban and also to engage a number of Indians to act as porters. It was somewhat difficult to estimate the amount of food required per person, and for this purpose we decided to make a preliminary or trial trip extending over three days. We found that an Indian consumed daily about half his straw hat full of 'topopoxti' or baked Indian corn cake, and this with a few onions and 'frijoles' or black beans supplied the necessities of life. Having arrived at the quantity required, we made up a sufficient number of loads and these were carried by the porters on their backs.

En route we occasionally discovered a small Indian settlement, where our "mozos" found shelter in a hut formed of poles and thatched on the top and on two sides. These were resting places used by the natives on their way to Salinas in search of salt. Salvin and I preferred, however, sleeping in our hammocks slung to the trees in the adjoining forest, and as we were each provided with a waterproof sheet, we slept in dry beds notwithstanding the constant wet nights.

The days were usually fine and were mostly spent in exploring the forest and collecting birds, insects, and plants. We remained a little over three weeks, till our supplies were exhausted, and then returned with our spoils to Coban.

Owing to my having contracted an attack of fever and ague in the low ground at Salinas I was unable to accompany Salvin on his journey to Peten and Belize. On his second expedition to Guatemala, Salvin had already visited Lanquin and Cahabon, about three or four days' journey from Coban. He describes ('Ibis,' 1861, pp. 138–149) the country as very wet and covered with forest, the roads —or rather tracks—impassable for animals, and all baggage had to be carried by Indians. The forests on the slopes of the limestone mountains were the home of the Quezal, the royal bird of the Aztecs, as well as of many other birds not found on the Pacific side, such as members of the families Cracidæ, Tinamidæ, etc. Salvin says: "These forests are perhaps more worth seeing than anything in Guatemala, quite different to those on the West Coast, where the heat is excessive and mosquitoes and other insects abound and destroy one's comfort. In these forests it is otherwise; no 'garrapatas,' no mosquitoes, and a climate in the dry season which might challenge any in the world. Most parts are free from brushwood, and one may ramble where one pleases without being stopped by dense thicket. What strikes the eye most is the number of ferns, not only of plants, but of species; every tree is clasped, every stone clothed with them, besides many of terrestrial habit."

As soon as I had recovered from the effects of fever, I left Coban for Buenaventura on the Motagua River in order to collect fish, and the methods employed have already been described on a preceding page.

Salvin then revisited his old quarters at San Gerónimo, and taking his friend Robert Owen, the proprietor of the Hacienda, with him, he rode over the high land round Quiché and Totonicapam at an altitude of 10,000 feet. Here the climate is temperate, potatoes and wheat are largely grown, and on the uncultivated ground oaks, pines, and alders abound. Thence, crossing the Cordillera, he proceeded to Quezaltenango, a large town in the 'Altos,' and the capital of a considerable district, which he describes ('Ibis,' 1865, p. 187) as a corn growing and sheep producing highland; thence to Retalhuleu and on to the port of San José. At Retalhuleu he he rd such glowing accounts of the prospect of obtaining a valuable collection of sea-birds and fish from the lagoons on the coast that he took a passage in a trading barque which was going from San José to Champerico to take in a cargo of coffee and sugar, and succeeded in procuring a large number of specimens.

When Salvin had finished collecting on the lagoons, he made an expedition to a belt of tropical forest parallel to the coast, but about twelve miles distant. Here it was that he specially remarked the contrast between the birds of the Pacific and Atlantic coasts—many of the most familiar birds of the low forest of Vera Paz, the Tinamidæ, *Columba nigrirostris*, and *Ostinops montezuma*, being entirely absent, nor does one find the genera *Rhamphocelus* or *Calliste*, or the beautiful *Cotinga amabilis*. Much of the forest consists of bamboo, with here and there a huge tree standing high above it. Between this forest and the coast the soil is comparatively unproductive, bearing the stamp of land reclaimed from the ocean at no very distant date. The long line of volcanoes suggests a recent upheaval, and the constant discharge of sand by every river would tend to advance the coast by slow degrees. This low country is very subject to malarial fever—although Salvin escaped, his two attendants contracted it. Salvin returned to England soon after this, early in 1863, but ten years later, in the autumn of 1873, he paid his fourth and last visit to Guatemala, this time in company with his wife; although he added considerably to our collections the route taken was much the same as on previous expeditions.

In this description of Guatemala, it must be remembered that when I visited it over fifty years ago there were no railways. There is now a railway from Puerto Barrios on the Atlantic Coast up the Motagua Valley to the capital and thence to the Pacific coast at San José, with a branch running from Mixtan near Escuintla to Retalhuleu and Champerico. The country, therefore, is at the present time readily accessible by steamer from Belize and thence from the Atlantic port by train.

SALVADOR.

Salvador, though the smallest of the Central American Republics, is one of the most densely populated and largely cultivated, and consequently there is but little forest. It is bounded by Guatemala on the west and Honduras on the north and east. The country averages about 60 miles in breadth, and the coast line on the Pacific is 160 miles in length. The seaboard consists of a comparatively narrow alluvial plain, beyond which is a plateau with a mean elevation of 2000 feet, broken by a number of volcanic cones lying to the south of the main Cordillera, and the whole Republic is very subject to earthquakes and volcanic outbreaks. The general aspect of Salvador led us to believe that the fauna and flora would be very similar to that of Guatemala and Honduras, consequently we neither visited the country ourselves nor did we employ any collectors there.

NICARAGUA.

The Republic of Nicaragua, wedged in between Honduras on the north and Costa Rica on the south, has a coast-line of about 280 miles on the Caribbean Sea and about 200 on the Pacific. The land gradually decreases in width from north to south, while the main watershed extends eastward from within a few miles of the Pacific Ocean. Greytown (San Juan del Norte), at the mouth of the San Juan River, formerly possessed a fine harbour, but of late years the Colorado branch of the river, which bifurcates about twenty miles from the coast, now takes most of the water and the old channel and harbour have silted up. The main geographical feature of the country is the remarkable depression stretching for about 200 miles from the north-west to the south-east, parallel with the Pacific Coast and to the central plateau. This depression, which lies at a mean elevation of about 100 feet, is flooded by two great lakes, Managua and Nicaragua, which collect the drainage-water of the western provinces and also that from the eastern range of mountains, finally discharging it through the San Juan River into the Caribbean Sea, a distance of 120 miles. The Lake of Managua is about 50 miles in length and 25 in breadth; the level is 16 feet higher than that of Lake Nicaragua, but the natural outlet, except in high flood, carries but little water, the surplus passing off by evaporation. The Lake of Nicaragua is about 100 feet above the sea-level and 150 miles long. Throughout its entire length this great depression is traversed by a remarkable chain of isolated volcanic cones, which, north of the lakes, takes the name of Marabios, terminating at the extreme north-west with Coseguina (4000 feet), and in the extreme south-east in the low wooded archipelago of Solentiname and Chichicaste, near the entrance to the San Juan River. These volcanoes range from 4000 to over 6000 feet, while Momotombo, the highest point in the Republic of Nicaragua between the Gulf of Fonseca and Lake Managua, reaches an altitude of

7000 feet. To the above mentioned series of volcanoes also belong those on the islands of Zapatero and Ometepe, in the lake of Nicaragua. The latter, after a long repose, burst into renewed activity in 1883, and for seven days continued to spread devastation, destroying the crops and compelling the people to take refuge on the mainland. Several other volcanoes are still more or less active, and in 1835 Coseguina was the scene of one of the most tremendous eruptions on record. The outbreak lasted four days, during which time sand and ashes were carried to such a distance that they fell in Jamaica, Mexico, and Bogota. No rivers of any size flow westward to the Pacific, but the Lake of Nicaragua receives, near its outlet, the important Rio Frio from Costa Rica, which, at certain seasons, brings down a vast amount of water. Little is known of the region of rugged plateaux and savannas occupying fully half the country between the lacustrine depression and the Caribbean Sea. A large portion of the low ground is said to be covered with dense forest intersected by innumerable streams, all flowing eastward to the Mosquito Coast, which is low, swampy, and very unhealthy.

Mr. Thomas Belt, a mining engineer and a well known naturalist, spent over four years at the gold mines of Santo Domingo in Nicaragua, and published an excellent account of his travels on his return in 1874. A considerable part of his book is occupied with extremely interesting observations on the Indians and the natural history of the district through which he passed, and I am indebted to him for the following details. Landing at Greytown he proceeded in an open boat up the San Juan River, which he describes as having a dangerous bar, over which he had to pass; he then entered a wide channel with shallow water and beds of high grass on one side and a sandy shore on the other, in which alligators floated about like logs of wood and flocks of wading birds were seen in the marshes beyond. Proceeding up the river in still water, he emerged into a wider channel with a stronger current. The banks of the river were at first low and marshy, intersected by numerous streams fringed chiefly with palms and beds of wild cane and grass; further up the banks became higher and drier, and plantations of bananas and plantains were noticed in the clearings of the forest. About twenty miles above Greytown Mr. Belt reached the Colorado branch of the river, which now takes the greater part of the water from the lake to the sea by another outlet. There the banks were hidden by high trees laden with creeping and twining plants, many of which bore beautiful flowers, while beneath were tree-ferns with their light green foliage and slender stems. Higher up he passed the mouth of the Chiripo River, which rises in the interior of Costa Rica and joins the San Juan about thirty miles above Greytown. It is navigable for about twenty miles from this point, after which it becomes a rough mountain-torrent, and a mule track leads thence to San José, the capital of Costa Rica. At Castillo, on the river bank, a considerable quantity of 'Ulli' (ule) or rubber is collected by the Indians, which forms an important object of trade. This is obtained from a species of wild fig (*Castilloa elastica*), a plant with large leaves, differing entirely from that found on the banks of

the Amazon (*Siphonia elastica*), and which is prepared in another manner; the former is abundant in the forests of Nicaragua and Honduras. The San Juan River continues with much the same high forest on its banks as far as San Carlos, at the entrance to the Lake of Nicaragua; it is about 120 miles long and the lake is 107 feet above the sea, so the water falls a little less than one foot a mile. The height of the lowest pass between the lake and the Pacific Ocean is said to be only 26 feet, and consequently this is the greatest depression in Central America between the Atlantic and Pacific. Owing to the enormous reservoir of water in the lakes, it has frequently been suggested as a practicable route for a ship canal between the two Oceans.

On reaching the lake a sail was hoisted on board the little boat, and in a couple of days Belt arrived on the northern shore at Ubaldo, the landing-place for the machinery and goods destined for the mines at Santo Domingo. Leaving Ubaldo the road crosses some low rocky hills with scanty vegetation, consisting of spiny cacti, leathery leaved trees, thorny palms, prickly acacias, and bromelias with sharply serrated leaves; this being the dry season, the mule track was parched and dusty, though during the rains it becomes a slough of mud and water. The road led through the town of Acoyapo, which is in a grazing district with large cattle 'haciendas.' Soon after this, Belt crossed the range which divides the forest region extending from the mountains of Segovia to the Caribbean Sea, and separating it from the great lake depression. The savannas on this side were more humid and the moisture increased as he proceeded across the upper waters of the Mico River, which enters the sea at Blewfields. The black margin of a great forest, which had been visible for some time, was reached in the neighbourhood of Santo Domingo; the ranges of irregular hills running mainly east and west were covered with vegetation, which was usually enveloped in a dense mist and produced a most depressing effect. The last part of the road was through brushwood, which had sprung up where the high forest had been cleared for planting maize; but Belt soon found himself under a canopy of high trees the trunks of which were entwined with creeping aroids and lianas, sending down their great rope-like stems to the ground. This forest is always wet, and the undergrowth consists of small palms and magnificent tree ferns, with thin stems and delicate foliage, and broad leaved heliconiæ, leathery melastomæ, and flesh-coloured begonias, with a variety of other damp forest loving plants.

In 1872 Belt made a long journey to Segovia in order to engage labour, as the Indian miners mostly came from that province. The road lay over a rough forest country on the east side of the range dividing the great lake valley from Matagalpa, and this part of his journey strongly contrasted with any former one, as he was now at a long distance from the Atlantic, in a dry and arid region, due to the north-east trade wind having deposited its moisture on the intervening stretch of high land. Belt crossed several high ranges before reaching Ocotal, the capital of Segovia, situated near the sources of the Rio Wanks; here grew pine trees and evergreen oaks at

probably the southern limit of the former in Central America. Descending a steep slope beyond Ocotal, he came to a forest resembling that around Santo Domingo, though the trees were not so large, but tree ferns, palms, lianas, broad-leaved heliconiæ, and melastomæ were again abundant, and he was told that the Quezal, the royal bird of the Aztecs, was occasionally met with. Belt, having successfully obtained the required number of Indians, returned by nearly the same route to Santo Domingo, and shortly after left for England.

Mr. C. W. Richmond, who resided in Eastern Nicaragua from February 1892 to January 1893, when describing the climate, says [Proc. U.S. Nat. Mus. xvi. (1893)] that the east coast has a protracted rainy season of eight or nine months, with occasional spells of fair weather; the rainfall is enormous, in some years reaching 296 inches at Greytown. He went up the Rio Frio into Costa Rican territory, from the Lake of Nicaragua to the Guatusa Indian settlements, at the head of the canoe navigation. A shark, doubtless the same species as that known to inhabit the lake (*Carcharias nicaraguensis*), was seen as far up the river as he ascended. Later Mr. Richmond spent some months on the Escondido River, chiefly about 50 miles from the mouth. This river was formerly known as Bluefields, or Blewfields, and is probably the most important on the coast of Central America, with the exception of the San Juan. There is no troublesome bar, as is usually the case, and large ocean steamers ascend to Rama, 65 miles from the mouth, where two rivers, the Rama and the Sequia, join and form the Escondido. The banks for many miles, including both branches above Rama, are lined with banana plantations, the monotony of which is broken by the numerous picturesque ceiba and ebo trees which have been left standing in the clearings, while the dense tropical forest lies in the background. In the last 15 or 20 miles of its course, the river winds through dreary silico swamps nearly devoid of bird life, and then empties itself into the Bluefields Lagoon, 15 miles long and 7 miles broad. Mr. Richmond enumerates 281 species of birds which he observed during this journey.

COSTA RICA.

This country was not visited by either Salvin or myself, and I am indebted to Mr. Carriker, Mr. Ridgway, and other writers for the following information.

The little Republic of Costa Rica has an extreme length of 250 miles with a breadth of about 150. The greater part of the country is very mountainous, with narrow coastal plains on both sides, finally extending to about 30 miles in width in the north-eastern corner. The drainage system is complicated, the extreme northern portion is comparatively low, draining into Lake Nicaragua to the north and the San Juan River on the Atlantic; while on the eastern side the streams and rivers have their sources in the high mountains, and descend rapidly through narrow valleys or gorges, separated by abrupt forest-clad ridges, which are frequently very narrow. The

country is extensively wooded, the forests consisting of trees of all sizes, many of them attaining enormous girth and height, especially on the eastern slope, where the rainfall is most abundant; consequently, vegetation is there much denser and penetration very difficult. On the Pacific side the forests have less undergrowth, the trees are larger and taller, and progress through them is comparatively easy. There is, however, an exception in the Guanacaste region in the Nicoya peninsula, where great tracts of grass lands or savannas, with scattered patches of woodland prevail. Trees with berries and other kinds of fruit abound at all altitudes, furnishing food throughout the year for the multitudes of tanagers, finches, parrots, toucans, and trogons, while their blossoms give sustenance to innumerable humming-birds. The tree which, throughout the tropics, mostly attracts other birds is one of the Leguminosæ, bearing biennially great masses of fragrant tassel-like blossoms which persist for some days before fading, while the season of flowering extends over a period of more than two months; it is known as the 'guava' (this is not, however, the guayava of commerce).

On the Caribbean slope the rainfall is fairly continuous during the whole year, reaching on an average from 200 to 230 inches on the lower land. The greatest rainfall is from the middle of December to the middle of January, and again from the middle of June to the middle of August, while from January 15th to March 15th it is fairly dry and cool, and this season on the eastern slope is delightful. In the high regions the rainfall is less, and there are alternately six months of wet and dry season. During the first and last months of the rainy season the fall is slight and rarely of daily occurrence, while in July, August, and October it rains every afternoon, and often violently. During the dry season high winds prevail at all altitudes, but little if any wind blows during the wet season. Influenced by the constant rain, the vegetation is most luxuriant, and with it we find animal life consequently much more abundant. So numerous are the species that probably not less than three hundred and ninety land and fresh-water birds may be found on the lower portion of the Caribbean slope up to 3000 feet. The high peaks rising above the regions of the Central plateau constitute quite a distinct life zone. The main range of mountains extends from the extreme north-west to the eastern central portion, gradually increasing in height and ending in a chain of volcanoes reaching an altitude of from 8000 to 11,000 feet, including Poas, Barba, Irazu, and Turrialba. Here there is a break formed by two deep, broad valleys, the river Reventazon flowing in the one to the Atlantic and the Rio Grande de Tarcoles in the other to the Pacific; their sources are within half a mile of each other, the 'divide' or watershed being known as 'El Alto' and having an elevation of 5000 feet. The whole country to the south is an unbroken mass of mountains containing but few inhabitants except the rapidly diminishing Indians.

Mr. Carriker (Ann. Carnegie Museum, vi. 1910) considers that the Avifauna of Costa Rica is composed of three primal groups—the Boreal, the Sonoran, and the

Tropical,—the first two coming down from the north, the last coming up from the south, and all meeting in the Republic of Costa Rica. He says, and truly, that the geographical position and meteorological peculiarities of the country make this enormous bird fauna within its confines explicable, but at the same time they greatly increase the difficulty of a satisfactory disposition of many of the species with respect to life zones. The continent decreases from 3000 miles in breadth to scarcely more than 60 at the narrowest part of Costa Rica, and within those 60 miles are crowded a diversity of climatic conditions, altitudes, etc., scarcely paralleled in the world. The northern and southern forms of the Pacific and Atlantic lowlands meet here and overlap, a single remnant of the Canadian bird-fauna persists on some of the isolated peaks of the high mountains (*Junco vulcani*), while modified forms of this northern species are found on the high lands of Mexico and Guatemala. A very large number of North American migrants arrive during the winter months and distribute themselves widely as to altitude throughout the country. Mr. Carriker also observes that amongst certain species there is a seasonal migration from a higher to a lower altitude, doubtless for the sake of food, and Salvin and I noticed similar migrations of several species of birds in Guatemala; this was especially the case with humming-birds, which were very abundant at Dueñas during the flowering season, but in the dry season, when the flowers failed, this district was entirely deserted and the birds migrated to the Pacific Coast, where the atmosphere was damper and the blossoms on which they fed were abundant.

The cultivation of bananas, however, is having a marked effect on the birds, which are decreasing at an alarming rate, for in the few years since the establishment of the Fruit Company at Port Limon the forest has been completely cleared—not only there, but also southward towards the Talamanca district. Very few of the forest birds frequent the banana plantations, and with the destruction of the forest they recede or disappear altogether.

Mr. Ridgway ('Condor,' vii. 1905) gives an interesting account of Poas, which is the only active volcano in Costa Rica. After spending the night at San Pedro, he resumed his journey by bright moonlight at 4 o'clock the next morning. The 'lecheria' or dairy farm at the upper edge of the cleared zone was reached soon after daybreak, and the primitive forest which covers the last thousand feet of the mountain was then entered. No pine trees were found here, as would have been the case at the same altitude in Mexico or Guatemala, as south of Nicaragua they cease to exist. The density of the forest was, however, such that it was impossible to leave the track without cutting a way with 'machetes,' and as the undergrowth consisted mostly of slender climbing bamboos, with exceedingly hard stems, which almost filled the spaces between the trees, the difficulty of making much headway may be imagined. The variety of trees was very great, and all were laden with orchids, bromeliads, and mistletoes, the latter often conspicuously and brilliantly flowered and the bromeliads

of dazzling hues of orange, scarlet, and crimson. Here, too, was seen the Quezal, amid surroundings no less magnificent than itself.

Leaving the horses in the open basin of an ancient volcano surrounded by forest, Mr. Ridgway proceeded on foot to the summit of the cinder cone, but the view was disappointing, as the crater was filled with dense clouds, except for one moment, when a strong wind dispersed the mass of vapour and allowed a brief glimpse of the boiling lake, 400 metres below. From the summit a descent was made to the lagoon, another extinct crater filled with clear water almost icy in its coldness and surrounded by dense forest. The time spent on Poas was too short to learn much of the birds, but except at the summit they were everywhere found in great numbers.

At Bonilla, an estate on the Atlantic slope near Turrialba, the roughness of the ground and the density of vegetation in the hot humid zone made it very difficult to collect, but in the cleared areas, where the 'potreros' or pastures are found, the variety and abundance of birds was remarkable. In one locality at least four hundred species were obtained, and in the thick growth many escaped capture, while humming-birds were so plentiful that fifteen species were shot round one flowering 'guava' tree. From here also was witnessed a flight of migrating hawks, passing northwards in hundreds and thousands.

At Coliblanco, near Turrialba (6500 feet), the trees, including the brilliant scarlet-flowering *Erythrina*, were covered with creepers and epiphytes, while near the water-courses at least three species of magnificent tree-ferns were common, as well as *Caladium*-like plants with leaves large enough to form a shelter against rain. As might be expected at this altitude, the birds were mostly different from those of Bonilla.

Another interesting place was Pigres, at the mouth of the Rio Grande de Tarcoles, in the Gulf of Nicoya. Between this and the mainland proper lies the 'estero,' a broad creek of smooth water, bordered by dense mangrove swamps, somewhat narrow on the Pigres side where the land mostly consists of bare sand, but in places covered with trailing *Ipomœa*, bearing broad leathery leaves and pink flowers; matted clusters of thorny leguminous shrubs and thickets of low spreading mimosa-like trees interspersed with the poisonous manzanilla, formed the rest of the vegetation. Notwithstanding the dry season and the almost total absence of flowers, birds were very numerous in the vicinity of the village. Immediately beyond the fringe of mangrove swamps, on the other side of the 'estero,' a high mixed forest extended for many miles, the undergrowth consisting chiefly of small biscoyal palms bristling with long slender thorns of needle-like sharpness. Further inland these palms gave place to high cannas, and in the forest of tall trees, macaws, parrots, and parrakeets were numerous and noisy.

An expedition from Coliblanco was made to the base of the cinder cone of Turrialba, about 9000 feet. Here everything was different from what had been seen below.

The several hundred acres composing the 'potrero' resembled an immense well kept park, with long vistas through groves and clumps of magnificent trees on undulating grassy slopes, cropped closely by the grazing cattle. On the right rose the cone of the volcano, covered with dense 'chaparral,' or bush of evergreen oaks, while to the left the long ridge-like mass of Irazu was plainly visible.

Mr. Ridgway made an ascent of this volcano, about 11,500 feet. The forest, of which but little remains, consists chiefly of oaks and differs widely from that of Poas and Turrialba. Higher up and close to the ash-cone the trees become scarce and scrubby, and finally only a growth of stunted *Vaccinium*-like shrubs exist.

It is remarkable that in Costa Rica at least 700 species and subspecies of birds have been found. Dr. Outram Bangs, when alluding in the 'Auk' (1907) to the Costa Rican collections made by Mr. Underwood, remarks that the extensive bird-fauna of this small country, scarcely larger than the State of Florida, is due to the fact that the Central American forms extend to the Atlantic lowlands, while those from Panama and the south go up the Pacific slopes, separated only by the range of high mountains.

An account of the Costa Rican Odonata, their larval forms and their habits, is given by Dr. Calvert in the 'Entomological News' for July 1910. He and his wife remained in the vicinity of Cartago for a year, making collections of Odonata as well as of terrestrial molluscs, annelids, araneids, orthoptera, microdiptera, coleoptera, and lepidoptera to a smaller extent, but they were hurried away by the severe and frequent earthquakes which finally destroyed the town in May 1910.

PANAMA.

This State—or Republic, as it must now be called—comprises the neck of land extending from Costa Rica to Colombia, an area equal in extent to about two-thirds the size of England and Wales, and forming the most southern country dealt with in the 'Biologia.' Very little, however, of the Isthmus of Darien, the land south-east of the Canal, has been visited by collectors. The main chain of the Cordillera decreases greatly in height towards the City of Panama, and between that place and Colon, where the railway and Canal traverse the country, the elevation falls to less than 300 feet. Salvin crossed by rail on more than one occasion, and spent some time collecting near the Station of Obispo, where he obtained a good many specimens; but Enrique Arcé and Mr. Champion were specially employed in Chiriqui, Arcé subsequently proceeding to Veraguas where he remained for several years.

The rivers, taken as a whole, are unimportant, but the Chagres with its tributary the Obispo attains formidable dimensions in the wet season, overflowing its banks and inundating a large area.

The district immediately adjacent to the Canal has recently been described by Mr. A.

Busck ('Report on the Mosquito Fauna of Panama,' 1908), who spent three months in the neighbourhood of Tabernilla near Colon. The ground slopes towards the Chagres River, and in the intervening country lies the bed of the old French sea-level canal which, even in the dry season, is covered with a series of shallow lakes connected by low marshes. Between these and the river are tall bamboos, sparsely interspersed with large hardwood trees, the crowns of which are covered with parasitic plants, orchids, and tillandsias, the last named affording a breeding place for several species of mosquito.

When Mr. Champion visited Panama in 1881–1883 he investigated the Pacific slope only, that on the Atlantic side being very inaccessible, and except at Colon and along the railway, or near the coast, there were no villages or means of obtaining food or shelter. He endeavoured to ascend the Volcano of Chiriqui, which attains an elevation of 11,000 feet, but the only route through the forest lay by narrow tracks made by tapirs, and on reaching the summit of a ridge, at 8000 feet, further progress was impossible, owing to the presence of an immense ravine, from which the upper part of the volcano could alone be seen. The night was spent in a hut erected by orchid collectors, but as no water could be obtained he was obliged to descend the following day.

On the western slopes of the volcano the savannas reach an altitude of about 6000 feet, while at 4000 feet cattle are pastured in large numbers for the Panama market. Higher up, to the north and west, a dense belt of forest covers the mountain side, but this does not extend to the summit. On the southern slope the forest had been cleared in many places for the cultivation of coffee, and a fine palm was locally abundant, but Coniferæ were entirely wanting. At Chorcha (300 feet) the dense forests descended to the coast and interrupted the continuity of the large savannas bordering the Pacific Ocean.

The Avifauna of Central America south of the Lake of Nicaragua, including Costa Rica, Chiriqui, Veragua, and Panama, is exceedingly rich. These countries contain more species than the whole of Europe, and nearly as many as the whole of America north of Mexico; 432 species have been found in Veragua, including Chiriqui.

Arcé's collections, like those of other naturalists who have since visited the country, were almost, if not entirely, made on the southern or Pacific slope.

Summarising his analysis of the birds of Veragua *, Salvin remarks (P. Z. S. 1870, pp. 178–179) as follows :—"The characteristic elements of the Central American fauna consist not so much in the amount of generic peculiarity, which is very small, as in the fact that a very considerable portion of South American forms are here represented, not as specifically identical, but, in a large number of instances, as definably distinct in degrees of varying value. The element of the Central American bird-fauna to be traced to the northern continent, on the other hand, maintains a very different relationship to the bird-fauna of that continent. With the exception of a few species

* Chiriqui was included by him under Veragua.

isolated in the mountains of the higher portions of the Isthmus, and some others, we find that northern forms found in Central America are specifically identical with northern species, and that their presence is due in a great measure to migration during the winter season. As regards numbers, we find a gradual diminution as we recede from North America. These migrants are everywhere present, some few passing still further south into the equatorial provinces of the southern continent. Costa Rica and Veragua, with Panama, possess these characteristics of the Central American fauna in the highest degree. It is here we find the greatest number of South American genera represented; but the species are to a considerable extent not the same as the continental species. If we endeavour to account for the facts as we find them, by changes in past times in the physical features of the Isthmus, we seem to require :— 1st. A union between Costa Rica, Veragua, and Panama with the southern continent, when those united lands possessed in common a much larger number of species specifically the same as at present, during which time the oceans may have been united north of Costa Rica. 2nd. The long duration of Costa Rica and Veragua as a 'continental' island, when the union of the two oceans has been of greater extent. This period must be long enough to have established specific differences much as we now find them. 3rd. The emergence of the whole Isthmus in its present form. These requirements seem to fall in fairly with what has been demanded in other branches of natural science. Dr. Duncan requires a union in Miocene times between the oceans to account for the specific identity of certain corals. The union here demanded will suit my first and second requirements, I only regulate the amount; and as for the period when it took place, fixing it to Miocene times would seem to answer to the requirements of the birds. That all the peculiar features of so varied a fauna can be accounted for by this theory I do not pretend to say. The changes in the physical features of the Isthmus, indicated by the numerous minor modifications of existing species, belong to the most recent events in geological history. To account for the greater differences observable we must go deeper into the abyss of geological time, where light is at present barely perceptible."

In his first paper on this subject (P. Z. S. 1867, pp. 129–161), based upon less extensive material, Salvin stated that there was a closer affinity between the birds of Veragua and those of Costa Rica than between those of Veragua and of the Isthmus of Panama, but this proved not to be the case when Arcé's later collections were examined. He then remarked that it was evident that Costa Rica and Panama had for a long period occupied the position of one or more islands between the two continents at a time when the two oceans were united by two or more channels; and that an obvious division separating Costa Rica, Veragua, and Panama from the southern continent was a line drawn from the Atlantic Bay of San Blas to the mouth of the Bayano on the Pacific.

PEARL ISLANDS.

In the Bay of Panama there lies a small group of islands known as Las Perlas, or the Pearl Islands, consisting of Pedro Gonzales, San José, and San Miguel; the last mentioned, also known as the Isla del Rey, is by far the largest, only twenty miles from the nearest mainland and sixty from Panama. This island is about fifteen miles long and irregularly oblong in shape, covered with low hills, which in turn are clothed with luxuriant tropical forest. The climate is hot and unhealthy, and the population consists almost entirely of negroes, who manage the affairs of the island and are very independent of the Panama Government. The pearl-diving industry having been almost abandoned, the people now grow vegetables, coco-nuts, and fruit for the Panama market.

Mr. Champion, who visited San Miguel on our behalf in April 1883, was only there in the dry season, and the "luxuriant forest" of other writers he describes as "scrubby wood." The interior was somewhat inaccessible, the few paths or tracks leading only to the patches of cultivated ground. The coast, like that of the adjacent mainland, is covered with mangrove-swamps, which can only be traversed at low water.

The Islands are in such close proximity to each other that probably the birds would be the same on each. On San Miguel 46 species were found, of which only four were considered by Mr. Bangs ('Auk,' xviii. pp. 24–33, 1901) to be well-marked island-forms, the remainder were, as might be expected from the semicircular form of the Coast of Panama, similar to those of the adjacent mainland. Some birds are undoubtedly carried across to the Islands by storms, but others perform the journey voluntarily, among them a small green humming-bird (*Chloristilbon assimilis*), which has been seen in perfectly calm weather flying straight for the Archipelago.

Certain well known butterflies from the mainland also occur, including a *Morpho* (*peleides*?), etc.

SOURCES FROM WHENCE OUR MATERIAL WAS OBTAINED.

The following particulars as to the sources from whence our material was obtained supplement the account given in the Introduction, *antea*, pp. 11, 12. In Volumes I. of the 'Aves' and of the 'Lepidoptera Rhopalocera' the names of the various collectors who were specially employed to obtain material for the present work are recorded, viz. Messrs. F. B. Armstrong, E. Arcé, G. C. Champion (1879–1883), W. Lloyd, W. B. Richardson (1897–1898), H. Rogers (1877), and M. Trujillo (1888), and Mr. and Mrs. H. H. Smith (1888). From many others, also, we acquired or received vast numbers of specimens, all of which were duly acknowledged by our Contributors.

As regards the Mammalia, Aves, Reptilia and Batrachia, Pisces, Mollusca, Lepidoptera Rhopalocera, and Neuroptera (Odonata), the sources from whence our collections were derived are mentioned in detail in the 'Introductions' to the volumes on these subjects and need not be repeated. The Coleoptera, or beetles, however, numbering 18,029 species in all, and requiring eighteen volumes for their enumeration, by twelve contributors, demand special notice. Notwithstanding their vast number, and the great abundance of individuals, this is the only group of insects, the Lepidoptera excepted, for which sufficient contributors have been forthcoming to enable us to complete their investigation. The Coleoptera, therefore, occupy in this work an undue amount of space amongst the thirty-eight completed volumes of Insecta, as compared with the Hymenoptera, Neuroptera, &c., certain important families of which still remain unworked, this being due to the fact that the beetles have proved more attractive both to the collector and describer.

The Coleoptera examined have been mainly supplied by the following collectors from each of the various countries:—Mexico—A. Sallé, C. T. Höge (who collected in nearly all the different States, Tamaulipas and Yucatan excepted), H. H. Smith (who specially visited Guerrero, Morelos, Vera Cruz, Tabasco, &c., for us), G. F. Gaumer (Yucatan), A. Forrer (N.W. Mexico, including the Tres Marias Is.), J. Flohr, F. D. Godman (Central and Southern Mexico), M. Trujillo (S. Mexico), Becker (Durango), Buchan-Hepburn (Chihuahua and Durango), and H. F. Wickham; British Honduras—F. Blancaneaux; Guatemala—A. Sallé, O. Salvin, J. Rodriguez, G. C. Champion, L. Conradt, and F. Sarg; Nicaragua—T. Belt, E. M. Janson, and W. B. Richardson; Costa Rica—H. Rogers, P. Biolley, Van Patten, C. F. Underwood,

and H. Lankester; Panama (including Chiriqui, the Pearl Is., and Taboga)—G. C. Champion, E. Trötsch, H. Ribbe, and A. Boucard. The Hymenoptera examined and reported upon by P. Cameron mainly consisted of the collections made by G. C. Champion in Guatemala and Panama, and by G. F. Gaumer in Yucatan, most of the vast number of specimens obtained in Mexico by H. H. Smith having been received too late to be included; it must be remembered, too, that the bees and social wasps have not been dealt with. The Lepidoptera, apart from the specimens captured by Salvin or myself, were obtained from the collectors who supplied us with the other insects; very extensive additions to both the Rhopalocera and Heterocera have, however, been made since 1900, especially by W. Schaus, who visited Mexico and Costa Rica in search of them. The Diptera examined were comparatively few in number, though H. H. Smith did his best in Mexico to make up the deficiency. The Rhynchota were very numerous, both in Heteroptera and Homoptera, as regards Guatemala and Panama, but till H. H. Smith went to Mexico we had received very little from that country, the habitat of most of the previously described species from our region. The Orthoptera, again, were few in number, none of our collectors having paid very much attention to them. The Arachnids were mainly supplied by H. H. Smith (Mexico), F. Sarg (Guatemala), and G. C. Champion (Panama); the Acaridea, however, were mainly procured by, and belonged to, Dr. Otto Stoll. In the Botany, the collections made by Mr. and Mrs. Salvin were used by Mr. Hemsley, but the study of the plants was almost entirely made from material contained in the Herbarium at Kew, including that which we had previously sent from Guatemala. Mr. Maudslay's work on the Archæology was based on his own observations on the various ruins visited during his sojourn in the country; Mr. J. S. Goodman, in his Appendix to this subject, gives an account of the system he used to decipher the Archaic Maya Inscriptions, which relate to a series of calendars.

Mr. Champion's Itinerary is given on pp. 46–54, and the places he visited in Guatemala are easily traceable on Map 8; we are unable, however, to find space on our other maps to include all the Mexican localities quoted in the Zoology and Botany, some of which, indeed, cannot now be traced *.

* It must be remembered that nearly all the names commencing with 'San,' 'Santo,' and 'Santa' have been used over and over again in the different States. The spelling of some of the others has been emended on our Maps to agree with official Mexican directories.

ITINERARY OF MR. G. C. CHAMPION'S TRAVELS IN CENTRAL AMERICA, 1879–1883.

The only detailed itinerary supplied by any of our collectors is that of Mr. G. C. Champion, who, it must be remembered, devoted almost the whole of his time to entomology. A brief account of the numerous Guatemala and Panama localities he visited will be of interest to entomologists. His expedition to Central America extended from March 16th, 1879–May 23rd, 1883. The itinerary of his travels*, which is here reproduced with additional details, appeared in the American 'Entomological News' for February 1907, pp. 33–44. The Guatemala routes are shown on Map 8. During his stay in that country, March 16th, 1879–April 7th, 1881, he investigated both the Pacific and the Atlantic slopes, the central plateau, &c. From August 10th, 1879–July 26th, 1880, he made his headquarters at San Gerónimo, six miles from Salama, and made many distant expeditions to various parts of Alta and Baja Vera Paz from that place. The central plateau was traversed from Salama (*viâ* Rabinal, Cubulco, Joyabaj, and Quiché) to Quezaltenango, and also from the latter place to the Capital. The Pacific slope was explored from La Gavia to the Mexican frontier of Chiapas, at elevations between 1000 and 4000 feet. The ports of San José and Champerico, the lagoons at Paso Antonio, and the lakes of Amatitlan and Atitlan were visited. The Volcan de Agua was ascended on January 13th, 1881. In Vera Paz, the Rio Dolores, near Cubilguitz, on the Coban–Peten road, was reached; and the Polochic Valley was twice visited, once by boat from Panzos as far as the Lake of Yzabal. An expedition was also made across the Chuacus range of mountains from San Gerónimo to Tocoy in the Motagua valley. Mr. Champion is of opinion that, from what he saw of the country during his travels, Guatemala might well be divided for zoological or botanical purposes into three (or four) districts:—(1) "The Atlantic slope," which is mainly of limestone formation in Alta Vera Paz, and has a very long rainy season—in Coban sometimes lasting into March,—and an abundance of humid

* All made on horse- or mule-back or on foot; the first Guatemalan railway—from San José to Escuintla—was opened just before he left.

forest; (2) "The Central Plateau," including the 'Altos,' which is an arid upland region becoming higher towards the Mexican frontier and bordered southward by volcanoes which protrude from the main cordillera—pines and oaks here clothe the mountain sides, on which cereals, maize, and, at high elevations, potatoes are cultivated; (3) "The Pacific slope," which has forest in the 'tierra caliente' and on the mountain sides, now largely replaced by second growth (rastrojo) or cultivated with sugar-cane, cacao, or (at elevations up to 4500 feet) coffee. The plain of Salama, in Baja Vera Paz, with San Gerónimo at its eastern end—draining to the Atlantic,—is very hot and arid, abounding in Cacti, Yuccas, Agaves, &c., like the Motagua valley, from which it is separated by the Chuacus range of mountains. The mountains to the north of this plain, as shown by the abrupt change in the nature of the vegetation between Salama and Purula or Tactic, form the dividing line between the humid Atlantic slope and the plateau. These lower central valleys must either be included under district 2 or treated as a separate faunal subregion. A comparison of the Lepidoptera Rhopalocera alone illustrates the great difference in the fauna of the two slopes *—many Erycinids, Ithomiids, *Heliconius*, *Papilio*, *Leptalis*, *Thecla*, &c., are peculiar to the Atlantic; while *Drucina*, *Euterpe*, a few special *Euptychia* and *Heliconius*, a *Morpho*, &c., are found on the Pacific. The dry central plateau doubtless forms an impassable barrier for many species, and it has altogether a very restricted butterfly fauna. In the mountains in the neighbourhood of the plain of Salama a few peculiar Rhopalocera occur, such as *Anæa nobilis* and *excellens*, &c. The 'tierra fria' or 'tierra helada' (10,000 feet and upwards) produced no alpine or subalpine forms, merely stragglers from below.

In Panama, April 17th, 1881–May 21st, 1883, Mr. Champion spent nearly all his time in Chiriqui, on the Pacific slope, between the Rio Chiriqui Viejo (near the Costa Rica frontier) and Tolé, making his headquarters at the various coffee-plantations on the mountain-slopes, at an elevation of 3000–4000 feet, or else at David or Bugaba. The Volcan de Chiriqui was ascended on June 7th, 1882, to 8000 feet, and the Cordillera above Tolé explored. The old route across the mountains from David and Caldera to the Chiriqui lagoon and the Bocas del Toro Islands, on the Atlantic side (used during the early days of the gold-mining in California, and before the Panama Railroad was finished), was found to be almost impracticable, and the northern slope was therefore not visited. The principal forests in Chiriqui are situated on the mountain slopes, in the low country to the east of David, and in the 'tierra caliente' to the west of Bugaba and Divala; the forests alternate with extensive savannas along the lower part of the Pacific slope and in the country immediately adjacent to the western precipices of the Volcan de Chiriqui. The whole of the towns and villages are situated in the 'tierra caliente,' and the Indians living in out of the way places in the Cordillera

* Unfortunately this could not be very well shown in the Table of Distribution of the genera given in the Introduction to the Rhopalocera.

or on the northern slope are very seldom seen. On the southern slope of the Volcano, between 2000 and 4000 feet, a great deal of the forest had already been cleared (in 1881) to plant coffee. San Miguel (Isla del Rey) in the Pearl Islands and Tobago were visited by Mr. Champion, in April and May 1883, from Panama, and a certain number of insects, &c., were collected by him in these places. The absence of Conifers in the mountains, the paucity of Cacti, and the much less arid nature of the country afford a striking contrast to Guatemala, the fauna of Panama being very similar to that of Tropical South America. There is no arid central plateau in Panama, and the Cordillera, the loftiest part of which is in Chiriqui, decreases towards the isthmus, where it is only a few hundred feet high, so that the fauna of the two slopes is not likely to differ greatly. The Atlantic slope, however, has not yet been investigated. A Tenebrionid-beetle of the seashore, *Phaleria dytiscoides*, is recorded by Mr. Champion as common to the coasts of British Honduras on the Atlantic and of Guatemala and Nicaragua on the Pacific [*cf.* Coleopt. vol. iv. pt. 1, pp. 218, 219 (1886)], indicating a former connection of the two oceans at the isthmus of Panama. His itinerary was as follows *:—

1879. March 16–18. San José de Guatemala, the Pacific port of arrival for travellers from Panama or San Francisco. Sea-coast, mangrove-swamps, lagoons, &c.

March 19, 20. Travelling up to capital *viâ* Escuintla, by diligence, over execrable roads, all inches deep in dust at this (dry) season.

March 21–April 2. Guatemala city (about 4500 feet). Open plains, intersected by deep barrancas (ravines). Scrubby oak and pine woods in places on hill-sides. The volcanoes Pacaya, Agua, and Fuego visible to the southward. Many insects found on the banks of the streams in the barrancas.

April 3–5. Ciudad Vieja. The first capital of Guatemala, in the valley between the volcanoes Agua and Fuego. Coffee-plantations and cultivated ground, unsuitable for collecting-purposes.

April 6–8. Guatemala city.

April 9. Aceituno. Coffee-plantation near the capital.

April 10–16. Guatemala city.

April 17–May 12. Capetillo. Valley between the volcanoes Agua and Fuego. Coffee and sugar-cane plantations, with the forest-clad slopes of the Fuego adjacent. This estate is the property of the well-known Guatemalan naturalist, Juan J. Rodriguez, who has, from time to time, for upwards of thirty years, supplied the editors of this work with material from his district.

1879. May 13–June 22. Zapote (about 2000 feet). On the forest-clad southern slope of the Volcan de Fuego. Broad, deep, dried-up watercourses, full of great boulders, run downward through the forest here, making travelling difficult. The locality good for insects. Coffee cultivated. Some very fine forest passed through at San Cayetano, between Zapote and Capetillo, along the descending coast-road.

June 24, 25. Antigua.

June 26–July 21. Dueñas (about 4500 feet). Near Capetillo. Coffee and Opuntia (for rearing the cochineal-insect) plantations adjacent to the Lake of Dueñas. Various excursions made from here to Calderas, on the upper eastern slope of the Volcan de Fuego, up to about 7500 feet. Pines on the higher slopes. Earthquake-shocks frequent—the house belonging to the owner of the estate (who had to leave it and live in Antigua) in ruins. The Acatenango peak of the Volcan, as well as the smoking Fuego itself, conspicuous from Dueñas.

July 22–Aug. 7. Guatemala city.

Aug. 8. Carrizal. Arid district with scrubby woods.

Aug. 9. Llano Grande (about 2600 feet). Scrubby woods, cultivated ground, and pasture. Mule-trains and Indians bearing heavy loads constantly met with here, the route from the capital to Salama, Coban, &c., passing through this place.

* Elevations approximate only, taken from an uncorrected aneroid barometer. Probably too low in many cases.

1879. Aug. 10–Sept. 9. San Gerónimo, Baja Vera Paz (about 2950 feet). East end of plain of Salama, and six miles distant from the town of that name. Hot, dry region, with many cacti. Chuacus range of mountains adjacent, bordering the plain southward; lower slopes clothed with pines, with forest of deciduous trees above. Sugar-cane and coffee plantations near village, belonging to English owners, the estate having a local reputation for the quality of the aguardiente (rum) and sugar produced by them. Drainage to Atlantic. Headquarters for about one year. Many long excursions made from here to distant places in both Alta and Baja Vera Paz, on the Atlantic slope. Some fine butterflies (*Anœa* spp.) peculiar to the Chuacus range. Various Longicorn (*Ochresthes*), Buprestid (*Acmœodera*), and other genera of Coleoptera characteristic of the drier portions of Mexico occur on the plain of Salama. A large Buprestid (*Chalcophora virginiensis*) in the pines on the Chuacus slopes. An Ithomiid butterfly (*Dircenna klugi*) seen swarming in the shady garden of the hacienda.

Sept. 10. Santa Barbara (about 4450 feet). Mountainous region east of San Gerónimo. Scattered woods. Pines below. Cultivation of maize, &c.

Sept. 11, 12. Santa Cruz (5500 feet). Mountainous region of Chilasco, the watershed between the Motagua and the Polochic, east of Santa Barbara. Scattered woods of *Liquidambar*, &c. Forest apparently all cleared in vicinity of village. Nights very cold here.

Sept. 13–Oct. 1. San Gerónimo.

Oct. 2–5. Purula (about 4000 feet). Open ground with a humid virgin forest adjacent on mountains. A new track through the forest towards Cerro Verde, an excellent entomological locality, the road to Sabo also productive. These localities again visited in April or May, 1880. The 'quezal' (*Pharomacrus mocinno*) not rare in the dense forest on the Cerro Verde road, and a 'Howler' (*Mycetes villosus*) frequently heard between Purula and Sabo.

Oct. 6, 7. Sabo (2900 feet). Clearing made in dense humid forest to plant coffee, on a steep mountain-slope. A very productive locality. *Pulex irritans*, however, swarmed to such an extent in the disused hut used for sleeping-quarters that it was impossible to remain very long in the place.

Oct. 8–15. Panimá * (1800 feet). Hot, narrow valley of the Rio Sinanja, a tributary of the Polochic. Valley, mostly cultivated with maize, &c., followed down to near Ribaco and upward towards Matanza. Road from Sabo descending very abruptly through forest in which a transparent-winged Pierine-butterfly (*Dismorphia fortunata*) was abundant.

1879. Oct. 16. Purula.

Oct. 17. Cachil. Open arid mountain-slopes north of the plain of Salama, with agaves, palms (*Thrinax*), &c. A peculiar *Euptychia* (*rubricata*) taken here.

Oct. 18–Nov. 3. San Gerónimo.

Nov. 4–6. Tocoy (about 2000 feet). Arid district on the Zacapa road.

Nov. 7. El Jicaro, near the Village of Guacamaya, on eastern slope of Chuacus range. Scrubby woods, pines above.

Nov. 8–12. San Gerónimo.

Nov. 13, 14. Purula.

Nov. 15. San Miguel Tucuru (about 2000 feet). Polochic valley. Mostly cultivated ground, cotton, maize, &c.

Nov. 16. La Tinta. Polochic valley. Tropical vegetation. Indigo formerly cultivated here, hence the name.

Nov. 17–23. Senahu (2800 feet). Limestone mountains north of the Polochic valley. Humid forests, cleared in many places for coffee-plantations. Long rainy season, but water scarce, rapidly disappearing underground. A district rich in land-shells. Again visited in June, 1880.

Nov. 24–30. San Juan (1800 feet). A small coffee-estate, no village, on the mountain-slopes north of the Polochic. Forest mostly cleared. Mountains of the Republic of Honduras visible to the S.E.

Dec. 1, 2. La Tinta.

Dec. 3–7. Tamahu, a few miles higher up the valley than Tucuru (about 2250 feet). Mostly cultivated ground.

Dec. 8. Santa Rosa (about 4000 feet).

Dec. 9–28. San Gerónimo.

Dec. 29. Tactic (4300 feet). Scattered *Liquidambar* and other deciduous trees. Forest all cleared to near the inaccessible mountain-tops. Large Indian population in district, hence the continuous clearing of the trees to plant maize ('milpas').

Dec. 30, 31. } Coban, Alta Vera Paz (about 3800 feet*).
1880. Jan. 1, 2. } Humid region, rainy season sometimes extending into February or March. Forest nearly all cleared to plant coffee, maize, &c. Numerous German traders and planters settled here. The residence for many years of a keen zoologist, F. Sarg. Large Indian population.

Jan. 3. Tactic.

Jan. 4–6. San Gerónimo.

* Misprinted 'Pancina' on many of the labels attached to insects in the collection made by Mr. Champion, and therefore wrongly quoted in some of the volumes of this work.

* Maudslay makes it 4280 feet.

1880. Jan. 7. Buenaventura.
Jan. 8–12. Guatemala city.
Jan. 13. Lake of Amatitlan (about 3450 feet). Arid district, with many 'nopales' (plantations of *Opuntia* for rearing the cochineal insect, all enclosed within dusty adobe walls). The Volcan de Pacaya not very far distant.
Jan. 14–18. Guatemala city.
Jan. 19. Buenaventura.
Jan. 20–25. San Gerónimo.
Jan. 26. Santa Rosa.
Jan. 27–Feb. 1. San Joaquin, Alta Vera Paz (about 3200 feet). Pine-clad, arid mountain-slopes. Rio Chisoy (or Chixoy) below. About the northern limit of the arid region of the central plateau.
Feb. 2. San Cristobal (4250 feet). Cultivated ground adjacent to the Lake of San Cristobal.
Feb. 3–5. Balheu (Valeu) (3850 feet). Pine-clad mountain-slopes.
Feb. 6–10. Coban.
Feb. 11. Chiacam (2400 feet). Coffee-plantations and scrubby woods.
Feb. 12. San Agustin Lanquin (1000 feet). Limestone formation. Second-growth woods; forest all cleared. Rio Cahabon, a large tributary of the Polochic, adjacent. An unproductive locality.
Feb. 13–23. Cahabon (Cajabon) (about 800 feet). Second-growth woods, forest all cleared near village. Large Indian population. No other people here, except the priest (who kindly accommodated stray travellers) and two or three Guatemalan officials. The very large church here is placed on a hill, higher than the smaller ones on which the Indians have built their huts. Plantations of cacao, maize, &c., around the village. Toucans seen in these places.
Feb. 24–28. Lanquin. The large limestone cave visited *, in company with an Austrian plant-collector casually met in the village. Only insects seen in the cave, an apterous Orthopteron (*Arachnomimus cavicola*). The Rio Cahabon, a broad stream, issues from its mouth, making its first appearance above ground at this place.
Feb. 29–March 6. Chiacam.
March 7–9. Coban.
March 10–20. Cubilguitz (1050 feet), near Choctum. Limestone region, with humid forest on the hills, the roads between the hills extremely bad. Broad valleys with scattered trees. The Rio Dolores reached, but not crossed. On main road from Coban to Peten, the track to Salinas (a place where salt is obtained and sent on Indians' backs to Coban) turning off to the westward near Cubilguitz. A good locality, but food absolutely unobtainable from the scattered Indian residents.
1880. March 21. Satchichá (2000 feet). In fording the river here my mule was so badly cut about the legs by the jagged knife-edged submerged limestone ledges that it was unfit for work for three months afterwards.
March 22–24. Coban.
March 25. Tactic.
March 26–April 13. San Gerónimo.
April 14–23. Purula.
April 24–28. Panima.
April 29–May 2. Sabo.
May 3. San Miguel Tucuru.
May 4–12. Chacoj, near Chamiquin, sometimes called La Hamaca (from the old suspended rope-bridge over the Rio Polochic) (about 500 feet). Tropical forest, with many palms (mainly *Attalea cohune*), which decrease in size as the Polochic is ascended. A new iron bridge in course of construction (in 1880). A very good entomological locality.
May 13–18. Teleman, on the Rio Polochic, the upper limit of navigation for small boats from the Lake of Yzabal. Tropical forests, with many palms, the leaves of the lofty *Attalea cohune* arching across the road. Culicidæ swarming. Unhealthy district. The 'Howler' frequently seen in the trees near the river. Some peculiar Syntomid-moths found amongst the prickly herbage.
May 19–22. Panzos, on the Rio Polochic. Tropical forests, &c., as at Teleman. Willows on river-bank. Unhealthy district. My first attack of fever here.
May 23. Danta, on northern shore of the Lake of Yzabal, about fourteen hours' journey by small boat from Panzos. Many alligators and 'Howlers' seen on my way down, manatees also noticed in the lake. Culicidæ swarming.
May 24–25. Travelling up the Rio Polochic, two days, against stream.
May 25–June 2. Panzos. Culicidæ (especially a sooty-black species) so bad here, even by day, that it was almost impossible to do more than a few hours' collecting at a time. Local name for them, 'zancudos.'
June 3–14. Senahu, travelling up from Panzos by way of Trece Aguas. [The American entomologists, Messrs. H. S. Barber and E. A. Schwarz (of the U.S. National Museum at Washington) have visited this district during recent years, and they succeeded in obtaining various minute Coleoptera of the same species captured by myself in 1880.]
June 15–21. San Juan.

* Also entered by Salvin, on March 8th, 1860 [*cf.* 'Ibis,' iii. pp. 140, 141 (1861)].

1880. June 22, 23. Chacoj.
June 24. San Miguel Tucuru.
June 25–27. Purula.
June 28–July 26. San Gerónimo. My last (8th) visit to this place.
July 27. Rabinal (2850 feet), *en route* for the 'Altos.' Dry region, with scrubby woods, cacti, agaves, yuccas, &c., as on the plain of Salama.
July 28. Cubulco (2900 feet). Similar country.
July 29. Joyabaj (4300 feet), an Indian village, reached by a long precipitous ascent from Cubulco. Open mountainous region, intercepted by deep barrancas. Pines and oaks on slopes. Central plateau becoming higher westward. An interesting butterfly (*Chrysophanus pyrrhias*) seen in numbers on the way up from Cubulco.
July 30. Santo Tomas Chiché (6100 feet). Los Altos region.
July 31–Aug. 5. Chimente, Quiché Mountains (7600 feet). Indian village. Oaks, pine, alder, &c., on slopes. Potatoes and maize cultivated. Cyanide bottles (with the results of a day's collecting) stolen from saddle-bags here.
Aug. 6. Totonicapam (7900 feet). Pine-clad slopes, but too far from the town for collecting purposes.
Aug. 7. Chevuc (9900 feet). Pine woods. Benighted at this place, having missed the road along the Cordillera to Los Encuentros in the dark.
Aug. 8. Los Encuentros (8400 feet). A resting-place for the night, on the road to Solola or the capital. Arid open ground. [Conradt collected insects at Tecpan, a place to the eastward.]
Aug. 9, 10. Desconsuelo (Solchicha) (about 10,500 feet). Pine-forests. Very bleak situation above Totonicapam. Carriage-road from Quezaltenango to Guatemala city passes this place, following the summit of the highest portion of the Cordillera. Potatoes only cultivated. A very good locality*, most of the Coleoptera, and some of the Lepidoptera Heterocera, collected proving to be new, but no peculiar butterflies were met with.
Aug. 11–15. Pachoc (or Patchoc) (9200 feet). Indian village. Pine-woods. Only accommodation obtainable a small schoolroom used during the day, the bare earth covered with pine-branches serving as a bed. Slopes of the Cordillera accessible from this place.
Aug. 16. Totonicapam.
Aug. 17–19. Quezaltenango (7600 feet). Cultivated ground mostly. Large Indian population. Unproductive locality.
Aug. 20–Sept. 9. Finca of Las Nubes on the southern (Pacific) slope of the Cerro (or Volcan) Zunil, above Mazatenango (4050 feet). Extensive coffee-plantations, with dense forest above. The most productive locality visited on the Pacific slope. Several new butterflies (species of *Drucina* or *Euptychia*) met with. An interesting bird (*Oreophasis derbianus*), a monkey (*Ateles ater*?), &c., seen in the forest. An enormous Passalid-beetle (*Proculus goryi*) found commonly beneath the large tree trunks left on the ground to decay in the 'cafetales' (coffee-plantations).
Sept. 10–23. San Isidro (1600 feet). 'Tierra caliente,' Pacific slope, below Mazatenango. Second-growth woods, cleared in places for coffee and cacao plantations. A *Caligo* plentiful in the tangled undergrowth, but difficult to secure.
Sept. 24. Retalhuleu (950 feet). Similar country. Now connected by rail with the port of Champerico.
Sept. 25–Oct. 7. Las Mercedes (3200 feet). Pacific slope. Immense coffee-plantations in this Costa Cuca district. Nearly all the original forest cleared.
Oct. 8–17. El Reposo (800 feet). Low country near Pacific. Mostly second-growth woods, but some forest, with lofty palms, in vicinity. Macaws (guacamayo's) often seen.
Oct. 18, 19. Paraiso (300 feet). Near Pacific. Scrubby woods, bamboos, &c.
Oct. 20–22. Champerico. Sea-coast. The remarkable fish (*Anableps dovii*) seen in the lagoons. [Also met with by Salvin, at Chiapam, near here.]
Oct. 23. El Reposo.
Oct. 24–26. Las Mercedes.
Oct. 27, 28. Coatepeque (1250 feet). Mostly cultivated ground. [Village almost completely destroyed by earthquakes during recent years.]
Oct. 29. Rio Naranjo (450 feet). Second-growth woods. Mexican frontier adjacent. A new iron bridge in course of construction.
Oct. 30. Near Naranjo. Benighted by losing road.
Oct. 31–Nov. 3. Finca La Union (2250 feet). El Tumbador district, department of San Marcos. Coffee-plantations and second-growth woods. No villages hereabouts, the town of San Marcos on higher ground in the Cordillera.
Nov. 4–7. Finca La Carolina (2600 feet). Tumbador district, overlooking lower portion of Soconusco, Chiapas, to Mexican coast, the Volcanoes Tacana and Tajumulco visible to the north-west. Unproductive locality.
Nov. 8. La Union.
Nov. 9. Rio Naranjo.
Nov. 10. Coatepeque.
Nov. 11–14. Las Mercedes.

* The insects from Desconsuelo and Pachoc were collectively labelled 'Totonicapam' (a town at the foot of the Cordillera) in the collections made by Mr. Champion.

1880. Nov. 15. San Martin, near Ostuncalco (7400 feet). Scattered trees, ground mostly cultivated.
Nov. 16–18. Quezaltenango. Cerro Quemado visited.
Nov. 19–Dec. 14. Las Nubes (Cerro Zunil). [The village of Santa Maria, on way down from Quezaltenango, almost destroyed during recent years by an eruption of the volcano of that name.]
Dec. 15. San Isidro.
Dec. 16–26. San Agustin (2250 feet). Southern (Pacific) slope of the Volcan de Atitlan. Second-growth woods, coffee-plantations, &c., all very dry and dusty at this season. Many Lepidoptera Heterocera taken 'at light' in the verandah of the house.
Dec. 27–29. San Lucas Toliman (4900 feet). Indian village on the borders of the Lake of Atitlan, which is very deep and has no visible outlet to the Pacific. Oak-woods, &c., arid region. Pampojilaj, on the coast road, visited, and the lake crossed (at night) to northern side. Numerous thickly populated Indian villages round the lake, the Indians not very friendly.
Dec. 30. Panajachel (4900 feet). Stayed at a flour-mill, close to the lake. The town of Solola not very far distant.
Dec. 31. San Lucas Toliman. Returned from Panajachel by a tortuous detour along the high ground above the lake.

1881. Jan. 1. Godines (6900 feet). Arid district above the precipitous cliffs bordering the Lake of Atitlan on the N.E. side. Magnificent view at sunset of the lake and the adjacent volcanoes and mountains to the southward during the cloudless skies of the dry season.
Jan. 2. Chimaltenango (5650 feet). Reached by way of Patzun and Patzitzia. Upland district cultivated with cereals.
Jan. 3–11. Guatemala city.
Jan. 12. Antigua.
Jan. 13. Volcan de Agua (about 13,000 feet) ascended at night (moonlight) from the Indian village of Santa Maria (6500 feet). Belt of deciduous trees above the cultivated ground to about 9500 feet, scattered pines above, even in crater. Path up deep and extremely narrow, between dense tussocks of high grass. Very few insects met with on summit, the butterflies seen merely common stragglers from below. Indians ascend to fetch a little ice obtained from holes made in the ground. So windy that it was impossible to remain long on summit, clouds forming rapidly after about 10 A.M.
Jan. 14. Antigua.
Jan. 15–Feb. 3. Pantaleon (1700 feet), Pacific slope. 'Tierra caliente.' Sugar-cane fields and second growth (rastrojo).

1881. Feb. 4–14. Mirandilla (1700 feet). Similar ground.
Feb. 15. Escuintla.
Feb. 16–18. Torola (1000 feet). Scattered patches of forest.
Feb. 19–28. Paso Antonio (400 feet). Open savannas, with scattered Crescentia and other trees, near Pacific, above Istapa. Lagoons here adjacent to the Rio Michotoya drained and used for pasturing the hungry cattle in dry season. Silurians and other fish captured in large numbers by the natives when the water becomes low in the lagoons, and iguanas also sought after, for food. Culicidæ and ticks very troublesome. Some new Dytiscidæ and other aquatic insects taken.
March 1–3. Torola.
March 4. Savana Grande, near the Rio Maria Linda (about 1150 feet). Scrubby woods, pasturage, and cultivated ground. Passed through village of Guanagazapa.
March 5. La Gavita (La Gavia) (1700 feet). Similar ground.
March 6, 7. Brito.
March 8–16. Torola. District swarming with ticks in dry season, and extremely unproductive, entomologically, like the rest of the 'tierra caliente' of the Pacific slope, during this period.
March 17–April 3. Guatemala city.
April 4, 5. Escuintla.
April 6, 7. San José de Guatemala. Left by coasting steamer on 7th *en route* for Panama.
April 9. La Union, Salvador. Landed for a few hours.
April 10. Corinto, Nicaragua. Landed for a few hours.
April 12. Punta Arenas, Costa Rica. Landed for a few hours.
April 17–20. Panama city. Left on 20th by small steamer for Chiriqui; the "port" reached by a tortuous passage through mangrove-swamps, navigable at high-water.
April 22–30. David. Principal town of Chiriqui. Open savannas, with scattered, leathery-leaved, deciduous trees. Denser growth by river-side and on hills adjacent, the latter productive, entomologically.
May 1–27. Finca Nance Bonito (about 2800 feet). Southern slope of the Volcan de Chiriqui. Plenty of forest, cleared in places for coffee-plantations, a fine palm locally abundant beneath the larger forest-trees, at about 2000 feet, just above the limit of the savannas. Coniferæ altogether wanting in the district, probably not reaching south of Nicaragua. Two species of monkeys (*Cebus hypoleucus* and an *Ateles*, almost certainly *geoffroyi*) seen. Productive locality.

1881. May 28–June 25. Las Potrerillas (El Banco) (about 2500 feet). Similar ground, not far from Nance Bonito.

June 26–July 13. David.

July 14–Aug. 1. Finca La Elvira. Similar to Nance Bonito.

Aug. 2–8. Las Potrerillas.

Aug. 9–11. Boquete (3550 feet). South-eastern slope of the Volcan de Chiriqui.

Aug. 12–20. La Caldera (1500 feet). Savanna region, with scattered trees. On old route from David to Atlantic coast, practical on foot only, but rarely used, all provisions having to be carried.

Aug. 21–Sept. 27. Las Potrerillas.

Sept. 28–Oct. 20. David.

Oct. 21–Nov. 28. Bugaba (1000 feet). Fine forests here *, extending into Costa Rica, eastward and southward savannas, with scattered trees. Rio Ascaria and Rio Chiriqui Viejo descending through forest-country. Sugar-cane and coffee cultivated to a small extent. The place of residence of the brothers Trötsch and other collectors formerly employed by Staudinger, the well-known Lepidopterist.

Nov. 29. Jugales. Resting-place on way up to the Potrero del Volcan.

Nov. 30–Dec. 10. Potrero del Volcan (4000 feet). Road from about 1000 feet above Bugaba rapidly ascending through dense forest. Savannas up to 6000 feet, to the precipitous western slope of the Volcan de Chiriqui (about 11,000 feet), and to the abruptly descending banks of the Rio Chiriqui Viejo. Dense forests westward and southward, in which peccary are not rare, and jaguars, &c., occur. Large numbers of cattle for the Panama market pastured on these savannas. Monkeys (*Ateles* sp.) and peccary (*Dicotyles labiatus*) sometimes shot for food by the 'vaqueros.' Uninhabited district.

Dec. 11, 12. Bugaba.

Dec. 13–26. David.

Dec. 27–31. } Bugaba.
1882. Jan. 1–Feb. 2. }

Feb. 3–5. Camaron (1750 feet). Milpas (maize-fields) in forest-clearings, on Costa Rica road.

Feb. 6–March 15. Bugaba.

March 16–21. Las Potrerillas. Country in a smoky haze at this season, due to the general burning of the undergrowth. Fires dangerous to the thatched houses, owing to the strong 'northers.'

March 22–April 10. Bugaba.

April 11–13. David.

April 14–18. Bugaba.

April 19–29. Potrero del Volcan. Second visit, more productive than first. Many large Lamellicorn-beetles (*Plusiotis*, various Dynastids, &c.) found floating in the water of the large shallow lagoons in the forest, on the banks of which numerous trees frequented by the insects were in flower. The short-tailed 'quezal' (*Pharomacrus costaricensis*) seen at about 5500 feet.

1882. April 30–May 30. Bugaba. A very good locality at this season, the commencement of the rains. New clearings in forest—made to plant rice, maize, or tobacco—productive in Coleoptera, Rhynchota, &c. A large number of interesting Lepidoptera Rhopalocera occur in the district, including *Morpho cypris* and other species of the genus. A marmoset, *Chrysothrix oerstedi*, occasionally seen in numbers on the outer limits of the forest; also an occasional peccary (*Dicotyles tapaju*).

May 30–June 5. Las Potrerillas.

June 6–8. Slope of the Volcan de Chiriqui (5500 feet). Staying in hut erected by Swiss orchid collectors on the very steep forest-clad slope. Ascended to 8000 feet, by tracks made by tapirs through the dense undergrowth of bamboo, &c., to summit of ridge. Further progress stopped by an immense precipitous ravine, beyond which the upper part of the volcano could be clearly seen through the trees. The vegetation on the summit consisted apparently of low bushes (? *Vaccinium*). No water could be found near hut and a longer stay not possible. Some interesting new Lampyridæ, Hispidæ, and other Coleoptera found in these places.

June 9–12. Las Potrerillas.

June 13, 14. Finca Nance Bonito.

June 15–July 3. Bugaba.

July 4. Jugales.

July 5–7. Potrero del Volcan.

July 18–Aug. 15. Bugaba.

Aug. 16–19. David.

Aug. 20–28. Bugaba.

Aug. 29, 30. Divala (Vivala) (350 feet). Savannas, covered in places with a short prickly *Mimosa*, the Rio Chiriqui Viejo adjacent. Tropical forest, with many lofty palms, westward. A 'road' into Costa Rica passes this place, not many miles from the Pacific. Eastward, on the savanna, is the old capital of the district, Alanje. Abandoned saw-mill noticed on one of the streams.

Aug. 31. Mosque (700 feet).

Sept. 1–Nov. 30. Bugaba.

Dec. 1–3. David.

Dec. 4–27. Bugaba. Garrapatas (ticks) swarming in the bush during dry season, necessitating a frequent change of clothing. Boas occasionally met with. Insects scarce, except near water, butterflies mostly

* Probably all destroyed by this time.

worn. Many species of latter found about the scattered pools of the nearly dry Rio Ascaria at this season, mostly Nymphalids and Hesperiids. Culicidæ not very troublesome.

1882. Dec. 28–30. David.

Dec. 31. Chorcha (300 feet). Dense forest, descending down to the mangrove-swamps of the coast, interrupting the continuity of the large savannas bordering the Pacific east of David, said to be infested with snakes.

1883. Jan. 1. San Lorenzo (200 feet). Savannas with woods here and there.

Jan. 2, 3. Los Remedios. A small port, reached through mangrove-swamps. Savannas inland.

Jan. 4–10. Tolé (1150 feet). Similar country. Excursions made from here to various places in Cordillera. Cattle-breeding the principal business here.

Jan. 11. Cerro Algodon (2000 feet).

Jan. 12–17. Peña Blanca (3000 feet). Very broken open country in vicinity of the Peña (Bluff). Slopes of the mountains covered with forest. Ascended to about 5500 feet. Indians from distant places on the Atlantic (northern) slope assemble in an uninhabited spot in the Cordillera near here annually. Dancing in the open air is kept up for two or three days, till most of the men and women become hopelessly drunk from the aguardiente supplied by travelling traders. The adults seen at one of these functions were tattooed with blue and red pigment.

Jan. 18. Cerro Algodon.

Jan. 19–22. Tolé. Nearly the whole of my money stolen from saddle-bags at this place, a return to David therefore imperative. Savannas east of Tolé, on the Santiago de Veraguas road, visited, but found to be unproductive at this (dry) season. Several interesting Malacoderm-beetles (*Astylus*, *Lycostomus*, &c.) were, however, taken from flowers. Very little cultivation seen.

Jan. 23–28. Nancito (800 feet).

Jan. 29. Los Remedios.

1883. Jan. 30–Feb. 3. San Feliz (650 feet). Savannas, with patches of wood.

Feb. 4, 5. La Isleta. Adjacent to the Rio Fonseca. A 'Howler' (*Mycetes palliatus*) seen in the trees along the streams.

Feb. 6, 7. Caña Fistula. Near the Montaña de Chorcha.

Feb. 8–10. David.

Feb. 11–March 3. Bugaba.

March 4–9. David.

March 10, 11. Bugaba.

March 12, 13. David.

March 14. Boquita, on way down to coast.

March 15–17. Boca Chica, near coast.

March 18–24. *En route* to Panama in small coasting-vessel carrying various passengers, who were accommodated in the open air on planks above the cargo of pigs. Punta Mala passed with difficulty.

March 25, 26. Panama.

March 27. Colon (Aspinwall). Many butterflies seen from train on way across isthmus, but next to none found at Colon.

March 28–April 2. Panama.

April 3–27. San Miguel, King Island (Isla del Rey), Pearl Islands. Scrubby woods much cleared in places to plant yams, &c. Tangled jungle, with some large trees, in southern portion of island. Coast fringed with mangroves and coco palms. Darien coast and mountains visible from San Miguel. A few interesting insects obtained. Unhealthy place. Too unwell to do much collecting. No horses or cattle. Tracks available along beach at low water.

April 28, 29. On way back to Panama in small boat.

April 30. Panama.

May 1–17. Taboga Island, Bay of Panama. Rocky ground, ascending to about 800 feet, with small streams. Pine-apples grown on the slopes, often stolen by sailors. Many butterflies and other insects occur on the island.

May 18–21. Panama.

LIST OF COMPLETED VOLUMES.

Zoology, Botany, and Archæology.

The 215 Parts of Zoology, 25 of Botany, and 17 of Archæology are divided into 63 Volumes, of which a complete list, with their contents, is given in tabular form on pp. 85, 86. The analysis of the contents of each of these volumes supplies the names of the contributors and other particulars, and, in the case of the Zoology, a brief summary of the author's views on the nature of the Fauna, as stated in their Introduction. The 215 * Parts of Zoology form 52 volumes—one devoted to Mammalia, four to Aves, one to Reptilia and Batrachia, one to Pisces, one to Mollusca, four to Arachnida, one to Chilopoda and Diplopoda, and thirty-eight to Insecta. The Crustacea, Protobracheata, Vermidea, &c., have not been studied, mainly for lack of material. Amongst the Insecta, too, no worker has been found for certain groups of Hymenoptera, Diptera, Rhynchota-Homoptera, and Neuroptera, and these omissions are specially noted in the analysis of the volumes dealing with the Orders in question. The 25 Parts of Botany form five volumes—four of text and one of plates. The 17 Parts of Archæology form four volumes of text, together binding into one volume, with an additional common titlepage, four volumes of folio plates, and an Appendix (text only), the whole subject thus extending to six volumes—two of text (quarto) and four of plates (folio).

* Part 211 was issued in two sections : "A" in Dec. 1911, "B" in May 1912.
Part 212 „ „ „ ; "A" in Feb. 1913, "B" in April 1914.

ANALYSIS OF CONTENTS OF EACH VOLUME.

1. The 'Introductory Volume' includes the general preface to the whole work, Zoology, Botany, and Archæology, a complete list of the subjects contained in each Volume, general statistics, maps, &c. The 'Contents' of this Volume, which forms the first of the entire series, are given in detail on p. iii.

ZOOLOGY.

2. MAMMALIA: by E. R. Alston, with an Introduction by Dr. P. L. Sclater.

The author of this Volume died on March 7th, 1881, before the enumeration of the species was concluded. The MSS., however, of the Supplement (pp. 203–212) was left by Mr. Alston in an almost complete state, and was finished by Mr. O. Thomas in 1881. The Tables (I.–VIII.), printed in the Introduction, were drawn up at our request by the author shortly before his death, and Dr. P. L. Sclater gives an analysis of them in his Introductory remarks on the subject (pp. x–xix), published in 1882. The total number of species enumerated is 181, of which a complete list is given in the Introduction (pp. iv–ix). These fall into five categories: (i.) Nearctic, 48; (ii.) Neotropical, 65; (iii.) Neogean, 17; (iv.) Autochthonous, 47; and (v.) Introduced, 4 (*Mures*). The eight Tables drawn up by the author show: I. General distribution; II. Nearctic species (17) found in the Northern States of Mexico, but not recorded from south of 25° N. lat.; III. Nearctic species (18) found in Central and South Mexico, but not recorded from south of the Isthmus of Tehuantepec; IV. Nearctic species (8) extending to Guatemala and Honduras, but not recorded from south of Nicaragua; V. Nearctic species (5) extending to Costa Rica and Panama, but not recorded from south of the Isthmus of Panama; VI. Species (17) common to the Nearctic and Neotropical Regions; VII. Species (47) peculiar to Central America, or not yet ascertained to occur elsewhere; VIII. Distribution of the Neotropical genera. Dr. Sclater (p. xiv) summarizes the analysis of the Central American Mammal fauna as follows:—"It may fairly be said that (excluding the introduced *Mures*) at least 100 of the constituent species are essentially Neotropicalin their character or have Neotropical affinities, while of the remainder not above 60 can be said to be decidedly Nearctic. There is therefore no doubt that the Central American isthmus, at any rate as far north as Tehuantepec, should be assigned to the Neotropical Region, of which it should be deemed to constitute a distinct province, characterized (1) by the incursion of a considerable number of Nearctic forms, especially in the northern districts, (2) by the presence of a certain number of peculiar

species of Neotropical genera, and (3) as being the focus of the families Procyonidæ and Geomyidæ, two well marked groups of Mammals which have extended alike into the Nearctic and Neotropical Regions."

The twenty-two coloured plates include figures of thirty-four species, a list of which is given on p. xx.

3–6. AVES: by O. Salvin and F. D. Godman: Vols. I.–III. (text), III. completed with the assistance of Dr. R. Bowdler Sharpe and Mr. Ogilvie-Grant; IV. (plates).

Three Volumes are required for the enumeration and description of the 1413 species of Aves belonging to the Central American fauna, and a fourth for the 84 plates. Vol. I., published in 1879–1887, gives an account of a portion of the Passeres, the families Turdidæ to Alaudidæ; and, on the conclusion of the work, in 1904, an Introduction to the whole subject was issued, with Tables (pp. xi–xxxviii) showing the geographical distribution of the families and species represented in Mexico and Central America. Vol. II., published in 1888–1897*, includes the continuation of the Passeres and the whole of the Macrochires, Pici, Coccyges, and Psittaci. Vol. III., published in 1897–1904, includes the Striges, Accipitres, Steganopodes, Herodiones, Phœnicopteri, Anseres, Columbæ, Gallinæ, Geranomorphæ, Limicolæ, Gaviæ, Tubinares, Pygopodes, Alcæ, and Crypturi. Vol. IV. contains the whole of the Plates and a complete list of the 149 species figured. Salvin's long continued ill health, and sudden death in 1898, retarded the conclusion of the Third Volume, and this was subsequently finished with the assistance of Dr. Sharpe and Mr. Ogilvie-Grant. For this reason, too, all idea of a Supplement was abandoned, notwithstanding the large amount of additional material which had come to hand during the progress of the work. The additions, however, were mainly amongst the Passeres, completed in 1892. The Introduction to Vol. I. (1904) contains an account of the authors' various expeditions to Central America, the sources from whence their material was obtained, &c., and the following particulars as to the nature of the Bird-fauna of the region:—To summarize the results, the Avifauna of Central America may be described as essentially Neotropical, with certain peculiar forms restricted to it. The fifteen families represented are all rich in endemic forms, and the families themselves are almost all tropical. On the other hand, a large number of species belonging to the more widely distributed genera find their winter home in Mexico and Central America, or further south, returning to breed in the Nearctic Region, even Humming-birds and others wandering far north at this season. The data is insufficient to show the lines of migration of all the species. Some, no doubt, travel southward from the United States to the mainland of South America by way of the Caribbean Sea or the West Indian Islands, perhaps just

* The permanent Titlepage and 'Contents' were issued in 1904.

touching the eastern portion of our region *en route*; others probably find their way down to the central tablelands, and a few western species, again, pass over the low lands of the Pacific coast.

Nearly half (636) of the 1413 species enumerated are treated as endemic, fifteen of the families—Trochilidæ, Fringillidæ, Tanagridæ, Formicariidæ, Dendrocolaptidæ, Troglodytidæ, Turdidæ, Psittacidæ, Phasianidæ, Peristeridæ, Cotingidæ, Trogonidæ, Cracidæ, Tinamidæ, and Rhamphastidæ—having many peculiar forms. Compared with America north of Mexico, the fauna of the region here dealt with is particularly rich, the numbers being, North America (1895) 768 species as against Central America 1413; while India (with Ceylon and Burma), with nearly double the area, has (1898) only 1626 species. All, or nearly all, the new species were described first in the 'Ibis' or 'P. Z. S.' by Salvin.

Birds, from their power of flight and the habit of migration common to a large number of them, are much more easily distributed than most other vertebrates, and, therefore, do not throw the same light on the subject of geographical distribution as in the case of more sedentary animals. This must, nevertheless, be applied in a general sense, for many of the species are extraordinarily local.

In dealing with the Aves the limits of the region have been extended to include the Revillagigedo Islands on the Pacific side, on account of the numerous sea-birds inhabiting them; the Island of Old Providence on the Atlantic side, which has a humming-bird peculiar to it; and some places on the Isthmus of Darien.

The eighty-four coloured plates illustrate 149 species.

7. Reptilia and Batrachia: by Dr. A. Günther.

The author, in his Introduction published in 1902, summarizes his remarks on geographical distribution as follows:—The general features of the Reptilian and Amphibian Faunas of the area under investigation have been satisfactorily ascertained. Forming the connecting link between the two Neogean regions, Central America possesses a Reptilian and Batrachian Fauna with the various constituent elements so mixed that, if only certain families or genera were taken into consideration, almost every district of this area could be associated with either the North- or South-American region. The tropical Fauna, as we proceed from lower to higher latitudes, gradually changes or is replaced by that of the temperate region; but this change is not uniform throughout the breadth of the land, and the two faunas frequently overlap in deep and manifold indentations. Tropical types are found to preponderate in the low lands of the Atlantic side, which expand into the broad Yucatan peninsula, and on the humid slopes of moderate elevation; some extend to, and even reach northwards of, the Rio Grande. On the Western side they are found in similar localities, but in a narrower belt, along the Pacific coast. On the other hand,

numerous types of the southern North American Fauna are spread over Northern Mexico, extending along the Central American plateau to the extreme limits of our area, and even beyond. This southward extension of northern types is due partly to the identical physical conditions of the arid tableland of Sonora and Chihuahua, which is merely a continuation of that of Arizona and New Mexico, and partly to the great altitude and temperate climate of the Central American plateau. Thus, a boundary line between the North and South American regions cannot be drawn: Central America forms a transition-tract unlike any other part of the world, showing the most extraordinary diversity of climatic, physical, and meteoric conditions within comparatively small areas, favouring the evolution of a great variety of types of genera and species, and influencing the dispersal of immigrants from the North and South.

The range of the 695 species enumerated is shown in the Table appended to the Introduction (pp. x–xvii).

Since the conclusion of Dr. Günther's work, Dr. Hans Gadow has twice visited Mexico (1902 and 1904), mainly to study the distribution, &c., of the Amphibians and Reptiles. He collected specimens of 135 species. The following papers have been written by him :—

(1) "Evolution of the Colour-pattern and Orthogenetic Variation in certain Mexican Species of Lizards, with Adaptation to their Surroundings" [Proc. Roy. Soc. Lond. lxxii. pp. 109–125, pls. iii.–v. (1903)].
(2) "The Mexican Axolotl" ['Nature,' lxvii. pp. 330–332 (1903)].
(3) "The Distribution of the Mexican Amphibians and Reptiles" [P. Z. S. 1905, ii. pp. 191–245].
(4) "A Contribution to the Study of Evolution based upon the Mexican Species of *Cnemidophorus*" (P. Z. S. 1906, i. pp. 277–375, pl. xx.).
(5) 'Through Southern Mexico.' London, 1908.
(6) "Geographical Distribution of Animals" ['Darwin and Modern Science,' pp. 319–336 (1909)].
(7) "The Effect of Altitude upon the Distribution of Mexican Amphibians and Reptiles" [Jahrb. Jena Abt. f. Syst. xxix. 1910, pp. 689–714].

He also published an excellent account of the portions of Mexico visited during his travels, and we give elsewhere a copious extract from one of his papers.

During recent years attention has been called to various Reptilia, Batrachians, Arachnids, Coleoptera, &c., living in the Bromeliads on the branches of trees. Specimens of *Spelerpes variegatus* and *Hyla godmani* were obtained from these plants by one of our collectors, Mateo Trujillo, in Mexico, and other species have since been captured by Dr. Gadow.

8. Pisces: by C. T. Regan.

The Introductory remarks to this subject (published in 1908) are arranged by the author under five headings :—(1) Principal Faunal Works on the Fresh-water Fishes of Mexico and Central America; (2) Principal Collections described in this Work; (3) Classification; (4) Geographical Distribution, illustrated by two separate maps; (5) The Shore-Fishes of the Atlantic and Pacific Coasts of Mexico and Central America. The geographical distribution is discussed at length under the headings to the separate families, ten of which are represented in the region, that of the Cichlidæ, Percidæ, Characinidæ, Catostominæ, and Cyprininæ being illustrated by shaded maps in the text. The author considers that the Nearctic and Neotropical Regions are quite distinct, and to explain the distribution of fresh-water fishes he says that the volcanic chain of mountains which stretches across Mexico from Colima nearly to Vera Cruz may be taken as the boundary. The Nearctic Region he divides into three subregions, one of which, the "Lerma," lies wholly within Mexican territory. The Neotropical Region is also divided into three subregions, the Central-American subregion again being separated into four "provinces," Balsas, Guatemalan, San Juan, and Isthmian; the limits of these are shown on Map 2.

Mr. Regan says that the Cichlidæ, which form a very large family of fresh-water fishes, is the dominant perciform group in Tropical America and Africa. In America the Cichlidæ extend from Texas to Argentina, and comprise about 150 species. Africa appears to be somewhat richer in both genera and species, whilst three representatives occur in India and Ceylon. A map is given in the text to show this distribution. He states that the Mexican and Central American Cichlids must have originated in the Southern Continent.

The Percidæ are fresh-water fish inhabiting Europe, Northern Asia, North America east of the Rocky Mountains, and Northern Mexico. Fossil Percidæ are found in the Eocene deposits of Wyoming.

The distribution of the Characinidæ, also fresh-water fish, is equally interesting. They extend from Northern Mexico over all the South-American continent, except the extreme south, and are found also in Africa, but not in Madagascar.

These two families and the Lepidosirenidæ support the theory that a land connection between South America and Africa may have persisted until the beginning of the Tertiary period.

The Catostominæ extend from Guatemala all over North America and into Eastern Asia.

The Cyprininæ are found from Canada southward to the Lerma Valley in Mexico and throughout Africa and Eurasia, except in the extreme north. They abound in Borneo, but are absent from Celebes.

Amongst the Shore-Fishes entering fresh water, eighteen Pacific coast species are specially noted as having a closely related representative on the Atlantic.

Mr. Regan concludes his remarks on these fishes as follows:—"The fact that in so many cases species may be paired is more in harmony with the view that there has been a gradual modification during isolation than with the supposition that a mutant has arisen which has replaced the parent form."

The twenty-six plates include figures of seventy-eight of the 415 species enumerated. The Maps inserted in the Introduction showing the distribution of certain families are worthy of attention.

9. Terrestrial and Fluviatile Mollusca: by E. v. Martens.

In this volume the author summarizes the characters and distribution of the species in common Tables, instead of giving separate descriptions. The geographical distribution is given at great length in the 'Introduction' (published in 1901), accompanied by separate Tables of the Terrestrial and Freshwater genera. The difference between the fauna of the Pacific and Atlantic slopes is noticed, but is stated to be not very important as regards the land shells. Central Guatemala (Baja Vera Paz), however, is said to be occupied chiefly by metamorphic rocks, while North Guatemala (Alta Vera Paz) is mostly of limestone formation: this difference accounts for the greater richness of land shells in the latter province. One peculiarity of the fauna of the Pacific slope is worthy of note, viz. the occurrence of large sized *Otostomi* and *Bulimuli* in Western Mexico related to various Andean forms, the distribution being somewhat analogous to that of the majority of the Cactaceæ. The submarine Mollusca of the eastern and western shores are said to be distinct, more so than some truly marine shells, but there are some remarkably analogous forms among them.

Of the forty-four plates belonging to this subject, the first twenty-eight are coloured.

[The Crustacea have not been studied.
The Freshwater Malacostraca were undertaken by Prof. T. H. Huxley, but his contribution was never finished.]

10. Arachnida Araneidea. Vol. I.: by the Rev. O. Pickard-Cambridge.

This volume contains descriptions and figures of 417 new species of Araneidea, and a list of species identified by the author. The new forms are illustrated on the thirty-nine coloured plates.

11. Arachnida Araneidea and Opiliones. Vol. II.: by F. O. Pickard-Cambridge.

Vol. II. of this subject gives the systematic arrangement of the whole of the species of Araneidea described in Vol. I. and the large number added in Vol. II. A synopsis of the Families is given on pp. 541–544. The 'Opiliones,' or 'Harvestmen,' are dealt with on pp. 546–585, and illustrated by three plates, LII.–LIV. The author is unable to say very much about the general distribution of the Araneidea, the material

at hand being insufficient for the purpose. They are said to date back at least as far as the Carboniferous period, when they were represented by forms of which the two species of *Liphistius* are the sole survivors. The earliest known Arachnomorphid spiders in any way resembling those living belong to the Oligocene times. At that period there existed many forms, very similar to those occurring at the present time, whose remains have been found in amber washed up on the shores of the Baltic Sea. The Opiliones are stated to have preceded, during the Carboniferous epoch, the air-breathing scorpion, *Anthrascorpius*, and their specialization probably began during the still earlier Silurian times, since in that period there existed an Arachnid which is a true scorpion in every sense, except that it had apparently no trace of air-breathing lung sacs. The 'Harvestmen' make no web for the ensnaring of their prey, and the females, after depositing their eggs, take no further interest in their offspring. In the two volumes 1181 species are enumerated, this number including the 422 described as new in Vol. II. The Opiliones number 70 species, 58 of which are described as new, with 11 new genera. The ninety-three plates (39 in Vol. I. and 54 in Vol. II.) include figures of 981 species.

12. Arachnida Scorpiones, Pedipalpi, and Solifugæ: by R. I. Pocock.

Very little material was available for the study of these Arachnids, sixty-nine species only being enumerated for the three groups. The twelve uncoloured plates include figures of thirty-seven species. The Scorpiones are represented by three families, the Pedipalpi by two, and the Solifugæ by a single family.

In this Volume the author gives the geographical distribution under the heading for each genus, and no general 'Introduction' to the whole subject was prepared, for want of data.

13. Arachnida Acaridea: by O. Stoll.

The material for this subject was obtained almost entirely by the author during a residence of nearly five years in Guatemala. He made the drawings on the spot, but unfortunately he had no modern literature on Acarids with him, and his microscope was anything but satisfactory. Dr. Stoll's work, therefore, must be treated as a contribution to the fauna of Guatemala, rather than as an enumeration of the Acaridea inhabiting Central America. The types of the species described remained in his possession. In his 'Introduction' (published in 1893), p. vii, he states that it is remarkable that not one of the forms described represents a generic type entirely new or peculiar to the region. Doubtless a great deal remains to be done in the way of collecting before we shall have any true idea of the Acarid-fauna of Central America.

The twenty-one coloured plates illustrate 43 species.

14. Chilopoda and Diplopoda: by R. I. Pocock.

The dates of publication of this Volume are, Chilopoda 1895–1896, Diplopoda 1903–1910. For the two groups 255 species are enumerated, of which 106 are described as new, the Chilopoda numbering 53 (19 new) and the Diplopoda 202 (87 new) respectively. The author, for want of sufficient data, does not give any particulars as to general distribution, beyond that mentioned under each genus or species in the text. The three plates belonging to the Chilopoda are partly coloured, the twelve others referring to the Diplopoda are uncoloured.

[The Prototracheata (*Peripatus*, &c.) have not been studied.
One species at least has been recorded from Nicaragua.]

15. Coleoptera. Vol. I. part 1: by H. W. Bates: Cicindelidæ and Carabidæ.

The author, who had previously studied the insect fauna of the Amazons during his long residence in that region, remarks, in his 'Introduction' (published in 1884), on the Central-American fauna of these two families as follows:—"The number of species (1086), belonging to 154 genera, is greater than the apparent poverty of tropical regions in Carabidæ would have led us to expect. The tolerably well-worked valley of the Amazons, although rich in species of genera belonging to alluvial plains, and in arboreal forms, contains only 576 species belonging to 124 genera; and the fauna of such tropical regions as the Malay archipelago is still poorer. The reason for the comparative paucity of Carabidæ has been supposed, apparently on good grounds, to be that their place, as predaceous terrestrial insects, is to a great extent occupied by the ubiquitous ants. The undoubted fact that purely epigæous Carabidæ, except marsh species, are scarce in the Tropics, especially near the Equator and in the low-lands, and that arboreal or climbing forms alone are numerous and varied, affords support to this hypothesis. The essentially Neotropical character of the Central-American fauna is generally admitted, and is strikingly confirmed by the Cicindelidæ and Carabidæ. But with regard to the northern limits of the fauna, and especially the extent to which Nearctic and North-temperate forms have penetrated the region from north to south, these are points not yet settled. Wallace included, or seemed inclined to include, the whole of the central highlands of Mexico and Guatemala in the Nearctic province, which must mean that the North-temperate American forms are there in the majority. The two families of Coleoptera we are dealing with do not support this conclusion. The Nearctic forms are comparatively few, and in the 'tierra templada' are far outnumbered by tropical genera. The northern limit of the Central American fauna appears to be—on the highlands, if not also on the maritime lowlands east and west—a little south of the political frontier of Mexico. Does the Central American fauna constitute one homogeneous province, or is it divisible into two subprovinces, as Salvin ('Ibis,' 1866, p. 202) has shown to be probably the case with

the birds, many genera of which are represented by distinct species on each side of a line which he is inclined to place north of the Nicaraguan lakes and their outfall, the Rio San Juan?"

The thirteen coloured plates include figures of 324 species.

Mr. Bates subsequently wrote two papers on the Mexican material received from our collectors after the present Volume was closed:—

(1) 'Additions to the Cicindelidæ Fauna of Mexico' (Trans. Ent. Soc. Lond. 1890, pp. 493–510, pl. 16).

(2) 'Additions to the Carabideous Fauna of Mexico' (*op. cit.* 1891, pp. 223–277, pls. 13, 14).

16. Coleoptera. Vol. I. part 2: by D. Sharp: Haliplidæ, Dytiscidæ, Gyrinidæ, Hydrophilidæ, Heteroceridæ, Parnidæ, Georissidæ, Cyathoceridæ, and Staphylinidæ.

For these nine families of Coleoptera 1790 species are enumerated, 1405 of which belong to Staphylinidæ, 168 to Dytiscidæ, and 141 to Hydrophilidæ, the others being of limited extent. The author, in his 'Introduction' (published in 1887), states that the water beetles (Dytiscidæ) are apparently subject to different laws of distribution from other Coleoptera, illustrating in this respect what he believes to be the case with aquatic organisms generally, viz. diminished endemicity, and therefore but little adapted for consideration in questions of zoo-geography. The study of the exotic Staphylinidæ appears to be practically in its infancy, and but little can be done in the way of comparison with the fauna of other tropical regions. In the case of genera with a large number of species and a wide distribution, the Central American Staphylinids are stated to be much more nearly allied to those of South than to those of North America. Dr. Sharp is therefore inclined to agree with the opinion expressed by Bates that the fauna of the region under investigation is essentially Neotropical. The Staphylinidæ first brought from the tropics included an undue proportion of comparatively large, bizarre, or brilliantly coloured forms, but it is clear that this was chiefly due to imperfect collecting. Indeed, one of the striking facts in connection with the material brought together by the Editors is the very large number of minute and obscure insects, so that it can scarcely be said that the Central American Staphylinidæ are, on the average, larger or more brilliant than those of Europe.

Of the nineteen coloured plates, fourteen are devoted to Staphylinidæ, 443 species being figured altogether.

17. Coleoptera. Vol. II. part 1: by Dr. Sharp, A. Matthews, and G. Lewis: Pselaphidæ–Byrrhidæ.

The twenty-two families enumerated in this volume are collectively termed Clavicornia by various authors, and in recent catalogues of Coleoptera the Erotylidæ,

Endomychidæ, and Coccinellidæ (these three families being here placed at the end of the Coleopterous series in Vol. VII.) are treated as belonging to the same division. The Silphidæ, Corylophidæ, Trichopterygidæ, Sphæriidæ, and Scaphidiidæ were worked out by Mr. Matthews, the Histeridæ by Mr. G. Lewis, and the remaining sixteen families by Dr. Sharp, the last named author also contributing a list of the Rhipidandri—a small group of somewhat uncertain position, but really belonging to the Tenebrionid-series near Boletophagini. The total number of species is 1629, of which 996 are described as new. The dates of publication of the various subjects are: Pselaphidæ and Scydmænidæ, 1887; Silphidæ–Scaphidiidæ, 1887–1888; Histeridæ, 1888; Phalacridæ–Byrrhidæ, 1888–1905; Rhipidandri, 1905. The 'Introduction' to this Volume was simply an editorial note; but in his remarks on the Histeridæ (p. 182) Mr. Lewis states that the chief interest of this series of insects centres in the species which feed on the wood-boring Coleoptera of other families. The nineteen uncoloured plates include, it is believed, some of the finest lithographic illustrations of beetles that have as yet been published, those devoted to the Colydiidæ (plates xiv. and xv.) being particularly excellent. The artist, Baron Max Schlereth, was unfortunately unable to draw the whole number.

18. COLEOPTERA. Vol. II. part 2: by H. W. Bates: Pectinicornia and Lamellicornia. The total number of species for these two important families is 1100—72 Pectinicornia and 1028 Lamellicornia. The author, in his 'Introduction' (published in 1890), remarks that the Pectinicorn-fauna is exceedingly poor in the chief family of the tribe, viz., the Lucanidæ; but, on the other hand, it is unusually rich in the more aberrant family, the Passalidæ. A comparison with such allied faunas from other parts of the world, which have been sufficiently worked out to give approximately accurate results, seems to show that the poverty in Lucanidæ arises from Central America lying too far south to have been reached by many species of Old-World genera, and too far north for the genera characteristic of South Brazil, Chile, and the Andes. The conditions seem, however, to be very favourable to the Passalidæ, which all pass their earlier stages in rotting tree-trunks, reaching their highest development and exhibiting more diversity of form here than in any other region. All the families of Lamellicornia are well represented in Central America; they include 1028 species belonging to 127 genera, but a comparison of the Lamellicorn-fauna with that of other tropical regions of similar extent is impossible, as the necessary data do not exist in a connected form. The actual number of species described up to 1890, for the whole world, may be roughly estimated at 10,000. Of the twenty-four plates illustrating the 492 species figured, all but one (Pectinicornia) are coloured.

Since this Volume was finished (in 1890) a good many species of Lamellicornia have been added by various authors, these showy beetles being great favourites

with collectors, but the additions do not materially affect the conclusions arrived at by Bates.

19. Coleoptera. Vol. III. part 1: Serricornia: Buprestidæ by C. O. Waterhouse; Throscidæ and Eucnemidæ by G. H. Horn; Elateridæ*–Dascillidæ by G. C. Champion.

For these families of the Serricorn-series, 1353 species are enumerated from Central America, 805 of which are described as new. The Buprestidæ were published in 1882–1889; the Throscidæ and Eucnemidæ in 1890; the remaining families in 1894–1897; and a short Appendix in 1897. The Buprestidæ, numbering 434 species (exclusive of those mentioned in the Appendix), do not appear to be very much in evidence, apart from the gigantic *Euchroma*, in the tropical forests of Mexico and Central America, their place being to a great extent taken by the conspicuous Elaterid-genera *Chalcolepidius* and *Semiotus*. The open parts of Mexico, however, have a rich Buprestid-fauna, as shown by the number of species obtained by Höge in his later expeditions to that country; these were enumerated in the 'Supplement' (published in 1889). The distribution of Conifers, which do not extend south of Nicaragua, probably affects the range of certain genera of this group. The Elateridæ, numbering 531 species, have exceedingly few endemic genera, and it may be said in a general way that the tropical forms are mostly confined to the forest regions, and that many of those inhabiting the open country or higher ground are nearly allied, or actually belong, to Nearctic genera. *Pyrophorus* has one species in North and sixteen in Central America, and is essentially Neotropical. The Dascillidæ, with 130 species and twenty genera, is one of the 'neglected' families of Coleoptera, and there are no available data for comparison with other regions. The Eucnemidæ, of which a table of the genera is given by Horn (pp. 211–213), are represented by 113, the Throscidæ by forty-four, the Cebrionidæ by twenty-nine, and the Rhipidoceridæ by fourteen species.

The twenty-seven plates, one of which shows the form of the terminal segment of the males of the Buprestid-genus *Pachyscelus*, illustrate 648 species.

20. Coleoptera. Vol. III. part 2: by H. S. Gorham: Malacodermata.

This Volume includes the following nine families:—Lycidæ, Lampyridæ, Telephoridæ, Lymexylonidæ, Melyridæ, Cleridæ, Ptinidæ, Bostrychidæ, and Cioidæ. The total number of species enumerated is 813; but as very many of our specimens added in the 'Supplement' were not critically examined by Mr. Gorham, it is probable that the actual number represented in the material obtained by our collectors is about 900. The author, in his 'Introduction' (published in 1886), states that it is now seen that

* First undertaken by E. W. Janson.

the tropical portions of the earth are as rich, or richer, in these groups (he presumably refers to Telephoridæ) than the cooler parts. The Lycidæ, Telephoridæ, Lampyridæ, and Cleridæ clearly show a closer relationship between our fauna and that of Tropical South America than with any they possess with that of America north of Mexico—this being rendered even more apparent in such large genera as *Calopteron* amongst the Lycids and *Chauliognathus* in the Telephorids. More striking, however, is the marked peculiarity of the Central and South American genera as compared with the faunas of other parts of the globe. The author remarks:—"If it were true that similar conditions would produce similar forms, how is it that the specialized genera of the Neotropical regions are so dissimilar from those of the Æthiopian and Indo-Malayan? Of the few genera common to Central America and to the Palæarctic or Tropical regions of the Old World, there is not one which is not of the rank of feebly differentiated forms, or persistent forms of an earlier stage of development. The total absence of many widely distributed well marked forms cannot be explained by any intrinsic dissimilarity in the conditions, which certainly do not differ more than they do in the wide areas over which such genera are dispersed, but rather by the isolation from these other areas, contact with which is only effected through the northern parts of the globe. One further fact is noted, viz., that, to whatever cause it may be due, where a genus is common to Central or South America and other distant parts of the World, it is also the case that it is represented by a species also identical or nearly related in the two districts. In this case its presence must be due to recent transmission, through artificial means, or to the conditions having long remained practically similar under which it exists in places so far apart."

Thirteen coloured plates are issued in this Volume, 330 species being figured.

Some of the Clerids received by us since the conclusion of Mr. Gorham's work have been described by Herr S. Schenkling in German publications, and a certain number of Bostrychidæ have been dealt with or revised by M. P. Lesne. The Chauliognathinæ, Malachiidæ, and Melyridæ, and a portion of the Ptinidæ, have also been revised by Mr. G. C. Champion (Trans. Ent. Soc. Lond. 1913, 1914).

21, 22. Coleoptera. Vol. IV. parts 1 and 2: by G. C. Champion: Heteromera.

The fourteen families included in the Heteromerous-series are dealt with in two volumes: (1) Tenebrionidæ, Cistelidæ, Othniidæ, Nilionidæ, and Monommidæ; (2) Lagriidæ, Melandryïdæ, Pythidæ, Œdemeridæ, Xylophilidæ, Anthicidæ, Mordellidæ, Rhipidophoridæ, and Meloidæ. The general 'Introduction' (published in 1893), which includes a Table showing the geographical distribution of the genera represented within the limits of Mexico and Central America, is given in part 1. The total number of species enumerated is 1776, of which 1295 are treated as new. Amongst the Tenebrionidæ, the apterous terrestrial forms clearly belong to the

Nearctic beetle fauna which extends down the central plateau to the Isthmus of Tehuantepec (*Asida*) or to the Los Altos region of Guatemala (*Elæodes*), while the winged forest forms are Neotropical. The winged genera inhabiting the open country (*Epitragus*, *Blapstinus*, *Xystropus*, &c.) have a wide distribution, and such apterous forms as appear to be insensible to drought and heat (e. g. *Zopherus*) range from the Southern United States through our region to Colombia and Venezuela. The humid forest regions of Central America possess a very rich Tenebrionid–fauna, as so many species attack decaying trees, or the fungi growing upon them, even in gloomy places; the Melandryidæ, however, are poorly represented, as in other tropical regions. The Cistelidæ, Xylophilidæ, and Œdemeridæ belong to the 'neglected' groups, not a single Central American species of any one of these families having been described before the publication of these volumes. The Meloidæ, on the contrary, had been studied by various Coleopterists, especially by E. Dugès in Mexico, and many of the species were previously described. The Heteromera, as stated in the Introduction, comprise a greater variety of forms than any of the other main divisions of the Coleoptera, nearly all of which are reproduced here. Probably no better case of mimicry or homochroism can be found amongst beetles than that existing between the Tenebrionid genus *Cuphotes* and *Cypherotylus* (Erotylidæ) and the Lagriid genus *Uroplatopsis* and *Uroplata* (Hispidæ). Some of the smaller subcortical Cucujids of the Clavicorn-series are so closely related to various Pythids—from which they are only distinguishable by the number of joints in the hind tarsi of the males—that it is probable that these latter will have to be removed eventually from the heterogeneous series of families known collectively under the name Heteromera.

The two volumes devoted to this group include forty-four coloured plates, illustrating upwards of 1000 species.

23. Coleoptera. Vol. IV. part 3: by D. Sharp and G. C. Champion: Curculionidæ (part).

The Rhynchophora, or weevils, include a larger number of species (3848) than any of the other main divisions of the Coleoptera, and no fewer than five volumes of the present series are devoted to their enumeration. In the First Volume (Part 3) 616 species of the following subfamilies of the Curculionidæ are dealt with: Attelabinæ, Pterocolinæ, Allocoryninæ, Apioninæ, Thecesterninæ, and Otiorrhynchinæ. Dr. Sharp's contribution, pp. 1–177, was published (pp. 169–177 excepted) in 1889–1891; this portion included the first five subfamilies and the apterous Otiorrhynchinæ, and that of Mr. Champion, dealing with the winged Otiorrhynchinæ, appeared in 1911. The Attelabinæ and Apioninæ, both numerous in species, do not differ greatly from the representatives of these subfamilies in temperate northern regions. The Pterocolinæ,

Allocoryninæ, and Thecesterninæ, each including a few species only, are common to North America and Mexico or Central America. The apterous Otiorrhynchids are mostly restricted to the central plateau—*Eupagoderes*, *Epicærus*, and *Epagriopsis* being the dominant genera in the highlands of Mexico,—while the winged forms preponderate in the warmer forest regions to the east, west, and south, this distribution being similar to that of the Tenebrionids. *Pandeleteius* and *Pantomorus* are characteristic winged genera in the open country. Various papers on the Apioninæ by Herr Hans Wagner, in which additional species from our region are described, have been published during recent years. Unfortunately, very little is known as yet of the actual food plants of any of the Central-American Rhynchophora.

The fifteen coloured plates include figures of nearly 400 species.

24. Coleoptera. Vol. IV. part 4 : by G. C. Champion : Curculionidæ (part).

The whole of this Volume is devoted to the Subfamily Curculioninæ, which are so numerous in the forest regions of Tropical America as to deter most Coleopterists from venturing to describe them. Twenty-two groups are enumerated, the Sitonina to the Cryptorrhynchina inclusive, numbering in all 1365 species, 1146 of which are treated as new. Some of the genera include a very large number of species : *Conotrachelus* (nearly 200), *Anthonomus* (over 100), *Hilipus*, *Otidocephalus*, *Cryptorrhynchus*, *Eubulus*, &c., so that it seems an almost hopeless task to prepare a complete list of these insects. Dr. Sharp and Mr. Champion have been the first to describe the whole of the Curculionidæ of a tropical country, and, though the genera of the Cryptorrhynchina still remain in inextricable confusion, the present contribution will doubtless be of considerable assistance to future workers. Some of the Groups, Anchonina, Cholina, &c., are purely Neotropical ; others, Pissodina, Sitonina, Hyperina, Balaninina, Cleonina (*Lixus* excepted), belong to more temperate regions, but extend southward to within our limits.

The thirty-five plates include figures of nearly 1000 species : nineteen (x. and xviii.–xxxv. inclusive) are coloured, one (xii.) partly coloured, and the rest uncoloured.

25. Coleoptera. Vol. IV. part 5 : by G. C. Champion : Curculionidæ (continued).

This Volume deals with four more Groups of the Subfamily Curculioninæ—the Zygopina, Tachygonina, Ceuthorrhynchina, and Barina, the vast complex mass known as Barina being represented by eleven Sections, all but three of which are purely tropical. The Zygopina also are almost entirely tropical, a few forms only occurring north of the Mexican frontier and they are wholly wanting in the European fauna.

The Ceuthorrhynchina, on the other hand, are numerous in temperate regions and but poorly represented in the tropics. Of the 908 species enumerated for the four groups mentioned, 620 belong to Barina; 717 are described as new, with 81 new genera.

The remaining groups of the Curculioninæ—the Acamptina, Trypetina, and Cossonina—are described in Vol. IV. part 7. The twenty-three plates belonging to Part 5, illustrating 720 species, are wholly or partly coloured.

26. Coleoptera. Vol. IV. part 6: Brenthidæ by D. Sharp; Scolytidæ by W. F. H. Blandford; Anthribidæ by K. Jordan.

Three families of the Rhynchophora are enumerated in this Volume: the Brenthidæ, published in 1895, by Dr. Sharp: the Scolytidæ, published in 1895–1905, by Mr. Blandford; and the Anthribidæ, published in 1906–1907, by Dr. Jordan. Part 6 was reserved for them in 1895, long before the Parts 4 and 5 were commenced. The general sequence of arrangement adopted in this work has therefore been interrupted by the interposition of these families in the present volume; the remainder of the Curculioninæ belonging to Part 5 were concluded in Part 7. The total number of species included in the three families is: Brenthidæ 140 (104 new), Scolytidæ 272 (181 new), and Anthribidæ 193 (148 new). The Brenthidæ are mostly confined to the forests of the tropics, and are particularly numerous in Tropical America, Madagascar, and the Indo-Malay region. As regards the Scolytidæ the author, Mr. Blandford, remarks that the genera are either cosmopolitan or Neotropical, some of the latter being represented by stragglers in North America; he also says that the southward limit of many northern forms is doubtless determined by the distribution of the Coniferæ, which do not reach south of Nicaragua. Dr. Jordan, in his introductory remarks on the Anthribidæ (p. 299), writes as follows:—"The present treatise offers an illustration of the great increase in the number of known species when a tropical district has been more exhaustively examined. Hardly three dozen forms were known from Central America, while the material now before me comprises close on 200 species." These insects are rarely found in large numbers, owing to their great resemblance to the bark of trees on which they occur. The author divides the Anthribidæ into two subfamilies, the Pleurocerinæ and the Anocerinæ, and gives a key to the whole of the genera (pp. 300–302). In the text the type of each genus is indicated, and the species of the larger genera are tabulated.

Fourteen plates are issued with this volume: three for the Brenthidæ, six for the Scolytidæ, and five for the Anthribidæ, the last mentioned being coloured.

27. Coleoptera. Vol. IV. part 7: by G. C. Champion: Curculionidæ (concluded).

This Volume finishes the Rhynchophora, the rest of the Curculionidæ belonging to the Subfamily Curculioninæ—the Groups Acamptina, Trypetina, and Cossonina—and

the whole of the subfamily Calandrinæ being here dealt with. An Appendix to the Curculionidæ is added, on pp. 178–212, enumerating a few additional forms and making some corrections to the synonymy. The Cossonina and Calandrinæ are each represented in Central America by a large number of species, some of the Calandrids attacking palms, cacti, sugar-cane, maize, Musaceæ, &c. The Mexican Cossonids (the genus *Cossonus* excepted) had been previously studied by Wollaston and the Calandrids by Chevrolat, nevertheless, with more abundant material, many new forms were found in our collection. Altogether 344 species are enumerated, 231 of which are described as new. The nine plates are coloured or partly coloured.

28. Coleoptera. Vol. V.: Longicornia by H. W. Bates; Bruchides by D. Sharp.

The greater part of this Volume (pp. 1–436), published in 1879–1885, is devoted to the enumeration of the Longicornia by Mr. Bates, the Bruchides, by Dr. Sharp, published in 1885, occupying pp. 437–504. Altogether the two tribes number 1423 species: Longicornia 1273 (648 new), Bruchides 150 (117 new). Mr. Bates, in his Introduction to the Longicornia, published in 1886, remarks as follows: "Compared with the Tribe Geodephaga, it is beyond doubt far more numerously represented in tropical than in extra-tropical lands, and its species and genera are naturally multiplied in the highest degree in tropical forests, where woody vegetable growths, to which the Longicornia are almost exclusively attached in their larval states, are most numerous and varied. Although their beauty of form and colour has led to their having been industriously collected, it is evident, from the number of new species continually arriving from countries supposed to be fairly well explored, that we are as yet far from possessing even an approximately complete knowledge of the whole product of Nature in this department. This is partly due to the recondite and, to a great extent, nocturnal habits of a vast proportion of the species, and the difficulty of the search for them in dense primæval forests where few clearings offer the necessary openings." The author thinks that the main conclusions arrived at after a similar examination of the Geodephaga are confirmed, viz. (1) that the Central-American fauna is essentially Neotropical; (2) that the northern portion of the region (Mexico and Guatemala) is not an extension southward of the Nearctic Province, but (3) that it is a remarkably distinct subprovince of the Neotropical fauna. Dr. Sharp, in his remarks on the Bruchides, numbering 150 in all, says (p. 437) that our knowledge of these insects is not sufficiently advanced to enable any trustworthy generalizations to be made in reference to the species found in Central America; and, as the northern parts of Mexico had been inadequately explored, it was not possible to say what relationship existed between the North American species and those of the regions southward.

Of the twenty-six coloured plates issued in the present volume, one only (pl. xxvi.) is devoted to the Bruchides.

Two papers on the Longicornia, subsequently received from our collectors after Vol. V. was finished, have been published, entitled: "Additions to the Longicornia of Mexico and Central America": one by Mr. Bates (Trans. Ent. Soc. Lond. 1892, pp. 143–183, pls. v.–vii.); the other by Mr. Gahan (loc. cit. pp. 255–274, pl. xii.). These additions bring the total number of species of Central American Longicornia to 1372.

29, 30. COLEOPTERA. Vol. VI. part 1, and Supplement: by M. Jacoby: Phytophaga (part).

The enumeration of the Phytophagous Coleoptera was commenced in 1880, before the Sallé collection had been acquired by the Editors and shortly after Mr. Champion had started on his journey to Central America. The collections made by him, and by Höge in various parts of Mexico, increased our material so largely that a Supplementary Volume was added. Hence, two bulky Volumes, together including over 1000 pages of text and forty-three plates, were required for the account of the Families Sagridæ, Donaciidæ, Crioceridæ, Megalopodidæ, Clythridæ, Cryptocephalidæ, Chlamydidæ, Lamprosomidæ, Eumolpidæ, Chrysomelidæ, and Galerucidæ. The Hispidæ and Cassididæ are described in Vol. VI. part 2. In the general Introduction to the two Volumes (Part 1 and the Supplement), published in 1892, the relative number of species for each family is shown in a Table, and the number of species of the larger genera (*Diabrotica* alone possessing 178, 116 of which are described as new, and *Lema* 129, with 73 new) is also noted. At the end of this Introduction, a systematic list of the whole of the species figured is given on pp. ix–xix. The Phytophaga are perhaps more in evidence, except in the denser forest districts, than any of the other families of Coleoptera in Tropical America, many of the species occurring in great abundance on the herbage in open places at the commencement of the rainy season. Some of them, like *Orina* in Europe, are extremely variable in colour, so that, as the author observes, nothing can be done by the systematic worker but to treat as distinct such forms as in his opinion differ sufficiently from their allies. Of the 2166 species enumerated (in 1892) only about 90 are known from north of the Mexican boundary and about 150 from south of Panama: Central America is thus shown to have an exceedingly rich and peculiar Phytophagous fauna, of which the affinities are much greater with South than with North America. Since the publication of these two volumes, very little has been added to the Central American list beyond a few forms described by Mr. Bowditch; Mr. Gahan's papers on *Diabrotica* dealt with South American species only.

About 1000 species are figured on the forty-three coloured plates.

31. Coleoptera. Vol. VI. part 2: by J. S. Baly and G. C. Champion: Phytophaga (part).

This Volume gives an account of the Hispidæ by J. S. Baly, published in 1885–1886, with a short Appendix, in 1894, by G. C. Champion; and of the Cassididæ by G. C. Champion, published in 1893-1894. For the two families 453 species are enumerated—Hispidæ 226 (169 new), Cassididæ 227 (55 new). The Central-American representatives of these groups are essentially Neotropical, America north of Mexico possessing a very limited number of species. Many of the characteristic South-American genera of Cassididæ, however, do not reach so far north as Panama, or, if present, are represented by very few species. Mexico is particularly rich in peculiar forms belonging to the genera *Chelymorpha*, *Physonota*, *Coptocycla*, &c. The Hispidæ attack Musaceæ, Bambusaceæ, &c., and abound throughout the warmer parts of Tropical America.

The thirteen coloured plates include figures of nearly 300 species.

32. Coleoptera. Vol. VII.: by H. S. Gorham: Erotylidæ, Endomychidæ, and Coccinellidæ.

The three families enumerated in this Volume are placed by recent writers in the Clavicorn-series, which are dealt with in Vol. II. part 1 of the present work. The total number of species is as follows:—Erotylidæ 282 (154 new); Endomychidæ 81 (39 new); and Coccinellidæ 239 (108 new). The Erotylidæ, including the Languriides, were published in 1887–1889, the Endomychidæ in 1889–1891, the Coccinellidæ in 1891–1898, and a short Supplement to all three families, and the Introduction, in 1898–1899. The Author, speaking of the Erotylidæ, exclusive of the Languriides, says that the members of this highly developed family of fungivorous beetles are largely endemic. The Endomychidæ are somewhat poorly represented in Central America; the Coccinellidæ, or 'lady-birds,' on the other hand, are very abundant in species and individuals, the phytophagous *Epilachnæ* in particular. The small Aphid- and Coccid-devouring Coccinellids have of recent years become of economic importance.

The thirteen coloured plates include figures of nearly 300 species.

This is the last of the eighteen volumes devoted to the Coleoptera; the total number of species enumerated is 18,029. Several genera of doubtful position, left undetermined by the various authors, have recently been described and figured, and the species of the genus *Hapalips* revised, by Mr. Champion (Trans. Ent. Soc. Lond. 1913, pp. 58–169, pls. iii., iv.).

33. Hymenoptera. Vol. I.: By P. Cameron: Sessiliventria and Petioliventria.

The fifteen families of Phytophagous or parasitic Hymenoptera worked out in this Volume number in all 1109 species, of which 596 are described as new. The

Sessiliventria include the Tenthredinidæ, Cephidæ, Siricidæ, and Oryssidæ, and the Petioliventria the Cynipidæ, Figitidæ, Chalcididæ, Ichneumonidæ, Braconidæ, Stephanidæ, Evaniidæ, Trigonalidæ, Pelecinidæ, Proctotrupidæ, and Chrysididæ. When Mr. Cameron's work on these insects was published, in 1883–1888, scarcely any Mexican material was available for study, and the numerous Ichneumonidæ described from that country in 1873 by Cresson could not therefore be identified. Mr. H. H. Smith subsequently made very extensive collections in Mexico of all the above-mentioned families, too late, unfortunately, to be included. Mr. Cameron's contribution, therefore, is very incomplete as regards the total number of species inhabiting the region, although it adds considerably to our knowledge of these Hymenoptera. The numbers of species for the different families are as follows: Tenthredinidæ 152, Cephidæ 1, Siricidæ 3, Oryssidæ 2, Cynipidæ 15, Figitidæ 5, Chalcididæ 121, Ichneumonidæ 533, Braconidæ 176, Stephanidæ 5, Evaniidæ 23, Trigonalidæ 9, Pelecinidæ 2, Proctotrupidæ 43, and Chrysididæ 19.

The twenty coloured plates include figures of 451 species.

34. Hymenoptera. Vol. II.: by P. Cameron: Fossores.

In this Volume the species belonging to the Section Fossores (the sand- and wood-wasps), under which the author includes the Family Mutillidæ, of the Hymenoptera Aculeata, are enumerated; the other Sections are known as Heterogyna (ants), Diplopterygia (Eumenidæ and Vespidæ), and Anthophila (bees). The Fossores, including Mutillidæ, number 711 species, of which 391 are treated as new, the total number being: Sphegidæ 67, Ampulicidæ 2, Larridæ 52, Nyssonidæ 32, Bembecidæ 26, Philanthidæ 54, Mimesidæ 8, Pemphredonidæ 3, Crabronidæ 24, Pompilidæ 163, Scoliidæ 59, Mutillidæ 221. The pages 1–400 were published between 1888–1896, the rest in 1899 and 1900. Mr. H. H. Smith's Mexican collections fortunately arrived in time to be included, so that the enumeration of the species in Vol. II. is more complete than in Vol. I. of the Hymenoptera. In the Introduction (published in 1900) there is a classified list of the 312 species figured on the fourteen coloured plates.

35. Hymenoptera. Vol. III.: by Prof. A. Forel: Heterogyna.

Volume III. of the Hymenoptera, published in 1899–1900, contains an account, in French, of the Heterogyna or Ants, numbering 382 species, 66 of which are described as new. From the author's remarks on page 1, it would seem that a large number of the Central-American forms are common to South America, and that the Formicid-fauna is mainly Neotropical. A few closely related S.-American species are described in foot-notes. The four uncoloured plates include figures of 57 species; plate II. shows the nests of various ants among leaves, or in the spines of *Erythrina*, *Acacia*, &c. A considerable number of species have been added to the fauna by Prof. Forel and other writers during the past ten years, showing that new forms still await the collector.

[The rest of the Aculeata, including the social-wasps, bees, etc., remain unworked, no contributor having been willing to undertake the large amount of material obtained in these groups. The late Lieutenant-Colonel Bingham commenced the study of the Diploptera shortly before his death, but nothing was published.]

36–38. LEPIDOPTERA RHOPALOCERA. Vols. I., II. (text), III. (plates): by F. D. Godman and O. Salvin; with (in Vol. II.) a Note on the Group Eumæidi by S. H. Scudder.

Vol. I. of the Butterflies, published in 1879–1886, the Introduction excepted, gives an account of the Nymphalidæ—including the subfamilies Danainæ, Satyrinæ, Morphinæ, Brassolinæ, Acræinæ, Heliconiinæ, and Nymphalinæ,—Libytheidæ, and Erycinidæ. Vol. II. includes the enumeration of the Lycænidæ (published in 1887), Papilionidæ, including the subfamilies Pierinæ and Papilioninæ (1889–1893), and Hesperiidæ (Hesperiinæ, 1893–1899, Pamphilinæ, by Godman alone, 1900–1901); a Supplement to the whole subject by Godman, pp. 638–741 (1901); and a Note on the Group Eumæidi, pp. 110–112, published in 1887, by Scudder. The Introduction to Vol. I. (pp. v–xlvi), by Godman, issued on the conclusion of Vol. II., in 1901, contains a description of the physical conformation of each of the countries belonging to the Central-American region; an explanation of the classification adopted; remarks on the leading forms belonging to each of the six families recognized (Nymphalidæ, Libytheidæ, Erycinidæ, Lycænidæ, Papilionidæ, and Hesperiidæ); a Table showing the geographical distribution of the genera (pp. xxii–xxvii); particulars as to the sources from whence the material was obtained, with the names of the collectors and some remarks on the places visited by them; and a systematic list of the whole of the species figured (1206) in the two Volumes (pp. xxxi–xlv), the plates numbering 112 in all. Altogether, 1805 species (Nymphalidæ 588, Libytheidæ 1, Erycinidæ 240, Lycænidæ 234, Papilionidæ 186, and Hesperiidæ 556) are enumerated, 376 of which are described as new, and 18 others from South America are added in foot-notes. In the Hesperiidæ the genitalia of most of the species are figured, many closely allied forms being definitely separable by these male-structures, and some of the species of the genus *Papilio* are similarly illustrated.

The study of these insects is said to prove conclusively (1) that the fauna is mainly a northern extension of that of Tropical South America, extending on the Pacific side to Mazatlan in Mexico and on the Atlantic side to a little beyond Ciudad Victoria in Tamaulipas, with many peculiarly modified forms in the region; (2) that there are a considerable number of Nearctic genera and species coming down the central plateau a certain distance into Mexico, and some even to Guatemala; (3) that there are no strictly alpine forms; (4) that the fauna of the Atlantic slope to perhaps as far south as Costa Rica is incomparably richer than the Pacific; (5) that some of the purely tropical genera do not reach north of Nicaragua, Costa Rica, or Panama. The publication of the concluding portion of the Rhopalocera, as in the case of the

Aves, was greatly delayed by the ill health and death of Salvin, in 1898; but he lived long enough to assist in completing the enumeration of the species of nearly all the families, with the exception of those of the subfamily Pamphilinæ of the Hesperiidæ, *i. e.* to p. 460 of Vol. II.

Amongst the numerous papers on Neotropical Butterflies that have been published since the conclusion of Vol. II. (in 1901), one by Mr. H. H. Druce (P. Z. S. 1907, pp. 566–632, pls. xxxi.–xxxvi.) contains a revision of certain Central-American species of the genus *Thecla*.

39–41. Lepidoptera Heterocera. Vols. I., II. (text), III. (plates): by Herbert Druce: Sphingidæ–Pyralidæ.

Vol. I. of this subject, published in 1881–1891, the Introduction excepted, contains an account of the following 22 families of Moths:—Sphingidæ, Castniidæ, Ægeriidæ, Agaristidæ, Zygænidæ, Arctiidæ, Chalcosiidæ, Lithosiidæ, Melameridæ, Dioptidæ, Liparidæ, Saturniidæ, Lasiocampidæ, Limacodidæ, Bombycidæ, Drepanulidæ, Psychidæ, Cossidæ, Hepialidæ, Notodontidæ, Noctuidæ, and Deltoidæ. Vol. II., published in 1891–1896, includes the Euschemidæ, Uraniidæ, Geometridæ, Siculidæ, and Pyralidæ; and a very extensive Supplement, pp 298–569, issued in 1896–1899, embraces all the families contained in both Volumes, another family, the Arbelidæ (pp. 449, 450), being added. The author, in his Introduction to Vol. I., published in 1900, states that in 1880 less than 400 species of Heterocera had been recorded from Central America against the 3639 enumerated in these two Volumes. The Table given on page ix shows the number of species belonging to each of the 28 Families and of those peculiar to the region. He says that it is almost impossible to give any generalizations as to the composition of the Central American Heterocera, because so little is known of the species inhabiting the adjacent parts of South America; but it may safely be said that their affinities are almost entirely South American, and the few northern forms that do occur mostly belong to widely distributed genera.

The 101 coloured plates include figures of 1926 species, a complete list of which is given in the Introduction to Vol. I., pp. xi–xxxi.

Since the conclusion of Mr. Druce's work, in 1900, a large number of species have been added, especially from Mexico and Costa Rica, mainly by Mr. W. Schaus, who has specially visited Costa Rica, &c., in search of Lepidoptera. Sir George Hampson, too, in his revision of the Noctuidæ, Pyralidæ, &c., has also contributed largely to our knowledge of the Tropical American Heterocera, the critical study of which had scarcely been commenced when Vol. I. was undertaken.

42. Lepidoptera Heterocera. Vol. IV. (text and plates): by Lord Walsingham: Tineina, Pterophorina, and Orneodina.

This Volume, commenced in 1909, contains the enumeration of the Tineina,

Pterophorina, and Orneodina, and a few supplementary genera and species omitted in the other volumes dealing with the Heterocera. The Tineina are grouped under 22 Families—Lavernidæ, Gelechiadæ, Œcophoridæ, Ethmiadæ, Blastobasidæ, Stenomidæ, [Ægeriadæ], [Cossidæ], Arrhenophanidæ, Sparganothidæ, Olethreutidæ, Tortricidæ, Phaloniadæ, Carposinidæ, Hemerophilidæ, Coleophoridæ, Heliodinidæ, Hyponomeutidæ, Phyllorycteridæ, Tineidæ, Acrolophidæ, and Nemophoridæ. Two of them, the Ægeriadæ and the Cossidæ, were previously dealt with in detail by Mr. Druce in Vol. I., their true affinities with the Tineina not having been recognized at that time. Lord Walsingham, in his Introduction, alludes to the great assistance he has received from Mr. J. H. Durrant in the preparation of this Volume, which is illustrated by ten coloured plates, representing 350 species of Tineina.

43. Diptera. Vol. I.: by Baron C. R. Osten Sacken, the Supplement by S. W. Williston, J. M. Aldrich, W. M. Wheeler, and A. L. Melander: Cecidomyiidæ–Empidæ.

Twenty-four Families of Diptera are enumerated in this Volume—Cecidomyiidæ, Mycetophilidæ, Bibionidæ, Simuliidæ, Blepharoceridæ, Culicidæ, Chironomidæ, Psychodidæ, Tipulidæ, Rhyphidæ, Stratiomyidæ, Tabanidæ, Chiromyzidæ, Leptidæ, Xylophagidæ, Acanthomeridæ, Mydaidæ, Nemestrinidæ, Bombyliidæ, Therevidæ, Cyrtidæ, Asilidæ, Dolichopodidæ, and Empidæ. Osten Sacken's work was published in 1886–1887. The Supplement by the American writers Williston, Aldrich, Wheeler, and Melander was issued in 1900–1901, and the editorial Introduction in 1901, on the conclusion of the whole subject. The material examined by Osten Sacken was very meagre, and though more specimens from Mexico were available for the Supplement, yet it was insufficient to give more than a general idea of the Dipterous fauna of Central America. The present Volume, therefore, is merely a contribution towards the study of these insects, rather than a complete list of the forms actually inhabiting the region. Altogether, 977 species are enumerated, 330 of which are described as new. The six coloured plates illustrate 120 species.

During recent years the Mosquito fauna of Panama has been specially studied in the canal-zone by Mr. A. Busck, and his report has been published [Smithsonian Contributions, vol. lii. pp. 49–77 (May 1st, 1908)]. Many new species of Culicidæ from Panama and other places in Central America have been described by Theobald, Dyar, and Knab.

44. Diptera. Vol. II.: by F. M. van der Wulp: Œstridæ, Muscidæ, and Hippoboscidæ.

This Volume contains the enumeration of the numerous groups of Diptera known collectively under the name of Muscidæ, for which abundant Mexican material collected by Mr. H. H. Smith was available, but the work was only about half finished when the

author died in 1899. No other contributor could be found to undertake the groups Agromyzinæ, Borborinæ, Chloropsinæ, Drosophilinæ, Ephydrinæ, Geomyzinæ, and Sapromyzinæ, of the Muscidæ Acalypteræ, and the Phoridæ, and the volume was closed as it stood. Pages 429-489, containing the Hippoboscidæ and the Supplement to the other families, were published after v. der Wulp's death, although the new species of Muscidæ Calyptræ had already been described by him in the 'Tijdschrift voor Entomologie' for 1892. Altogether, 1095 species were named by the author, of which 585 were treated as new, the publication of his work extending from 1888–1900, but the Titlepage and Introduction were not issued till 1903.

The thirteen coloured plates include figures of 287 species. Some of the Trypetinæ are figured on the plates, others (11) in the text.

45. Diptera. Vol. III.: by S. W. Williston: Syrphidæ, Conopidæ, Pipunculidæ, and Platypezidæ.

Prof. Williston's contribution to this Volume, pp. 1–89, was published in 1891–1892, and the list of subsequently described species, and the general index to the whole of the three volumes, pp. 93–127, in 1903. The material again was scanty in comparison with the large number of species which must exist in the region, but among the Syrphids the genera *Baccha*, *Volucella*, and *Eristalis* were particularly well represented. The total number of species enumerated is 325, of which 67 are new. The two coloured plates include figures of 29 species.

46. Rhynchota Heteroptera. Vol. I.: by W. L. Distant: Pentatomidæ, Coreidæ, Lygæidæ, Pyrrhocoridæ, and Capsidæ.

Mr. Distant's enumeration of the above mentioned families of Rhynchota Heteroptera (pp. 1–303) was issued in 1880–1884, the Supplement to the same (pp. 304–351) in 1889–1893, and the Appendix (pp. 452–462) in 1893, the delay in publishing the Supplement being due to his long absence in South Africa. Altogether, 1108 species are recognized, more than half of which are described as new. In the Introduction, published in 1893, the number of genera belonging to each family is given and the geographical distribution shown in short Tables. Amongst the Lygæidæ nearly half the genera are stated to be endemic. The Pentatomidæ include 377 species and are, therefore, very well represented in Central America, though many of the genera are common to the Neotropical region. The Capsidæ, too, with 313 species, are very numerous, but the tropical representatives of this family are but little known as yet, and no comparison with the fauna of the adjacent portion of South America can be made. The thirty-nine coloured plates include figures of upwards of 900 species, a complete list of them being given in the Introduction, pp. xi–xx.

47. Rhynchota Heteroptera. Vol. II.: by G. C. Champion: Tingitidæ–Corixidæ.

Mr. Champion here deals with nineteen families of Rhynchota Heteroptera (making twenty-four in all), twelve belonging to the Gymnocerata and seven to the Cryptocerata. The number of species enumerated is 592, nearly half of which are described as new. Fifteen additions to Vol. I., described or recorded by various authors in other works, between 1893 and 1901, are noted on p. 384, the total number of Heteroptera enumerated in the two Volumes being 1715. The Tingitidæ, Aradidæ, Reduviidæ, and Anthocoridæ are abundantly represented in Central America, the respective numbers for each being 78 (66 new), 78 (40 new), 204 (78 new), and 54 (32 new). As with the five families belonging to Vol. I., no comparison is made with the fauna of the adjacent regions southward for want of sufficient data. Most of the genera belonging to the aquatic Cryptocerata are, in common with other water-insects, more or less widely distributed. The twenty-two plates, six of which are coloured, include figures of 513 species, a complete list of which is given in the Introduction, pp. xi–xvi. The Index for the two volumes is included in Vol. II., pp. 385–416.

48. Rhynchota Homoptera. Vol. I.: by W. L. Distant and W. W. Fowler: Cicadidæ–Delphacidæ.

Mr. Distant's first contribution to this Volume, on the Cicadidæ and Fulgoridæ, pp. 1–41, was published in 1881–1887, the Supplement to the same, pp. 42, 43, in 1900, and the Appendix, pp. 140–146, in 1905, his work having been interrupted during long absences from England. The rest of the volume, dealing with three additional species of Dictyopharinæ, the Flatidæ, Derbidæ, Cixiidæ, Achilidæ, Issidæ, and Delphacidæ, by the Rev. W. W. Fowler, pp. 44–139, 146, 147, appeared in 1900–1905. Apart from the Cicadidæ and Fulgoridæ, very little appears to be known about the South American members of the above mentioned families, and nearly all the Central American representatives are described as new by Mr. Fowler. Altogether 323 species are enumerated, 208 of which are treated as new, with twenty-five new genera. The thirteen coloured plates include figures of 267 species, a complete list of which is given in the Introduction, pp. vii–ix. Four species of Cicadidæ are also figured in the text, on pp. 140–143. A few Central American Cicadidæ have since been described by Mr. Distant in other publications.

49. Rhynchota Homoptera. Vol. II. Part 1, by W. W. Fowler: Membracidæ–Gyponidæ. Part 2, by T. D. A. Cockerell: Aleurodidæ and Coccidæ.

Part 1 of this Volume contains the enumeration of four more families of Homoptera —the Membracidæ, Cercopidæ, Tettigoniidæ, and Gyponidæ, 659 species in all (exclusive of the 29 noticed in the Supplement, some of which are doubtful), 385 of of these being described as new, with 42 new genera. Pages 1–316 were published

in 1894–1903, and 317–322 in 1909, the conclusion of the Volume having been delayed for several years by the American contributor who had volunteered to determine the Jassidæ, Bythoscopidæ, &c. The MSS. and material not being forthcoming, the volume was closed as it stood. The twenty-one coloured plates, ten of which are devoted to the extraordinary insects known as Membracidæ, include figures of 494 species, a list of which is given in the Introduction, pp. vii–xi. The Index for Vols. I. and II. is also issued in this volume, pp. 323–339. The Supplement, pp. 318–322, contains notes on the 29 species added by Buckton and others during the progress of the work.

Part 2 of this Volume, by Prof. T. D. A. Cockerell, issued in 1899 (the separate Index, pp. 35–37, was not published till 1909, when Volume II. was closed), gives a list of the 161 Aleurodidæ and Coccidæ from Mexico and Central America known to the author at that date. Eleven species and two genera are described as new, and nine forms are figured in the text. With these insects, the total number of Homoptera recorded from Central America is 1143.

[The few specimens of Thysanoptera obtained have been examined, and some of the species described, by Mr. R. S. Bagnall (Journ. Linn. Soc., Zool. xxx. pp. 369–387, pls. ii., iii., 1910). Mr. D. L. Crawford has also recently written various papers on 'Thysanoptera of Mexico and the South' (Pomona Journ. Ent. i., ii. 1909–1910).]

50. Neuroptera: Ephemeridæ by A. E. Eaton; Odonata by P. P. Calvert.

The Rev. A. E. Eaton's account of the Ephemeridæ, based upon very few specimens, was published in 1892; that of the Odonata by Prof. P. P. Calvert, with abundant material, in 1901–1908 *. Altogether 308 species are enumerated: Ephemeridæ 32 and Odonata 276. Prof. Calvert's Introduction, pp. v–xxx (published in 1908), mainly consists of two Tables: (A) "Alphabetical List, by countries, of the localities in which the Odonata were collected," and (B) "Systematic list and distribution of the species and varieties," 293 in all; and a coloured map to show the actual distribution of mean annual temperatures. Table A gives the name of the Department, Territory, or State to which each locality belongs, the elevation of these places in metres and feet, the names of the collectors, the dates of capture, general remarks, &c. Table B shows the geographical distribution and the temperature zones in which the species occurs in each country, this being further illustrated by the map. The composition and ecological relations of the Odonate fauna of Mexico and Central America have been discussed by Mr. Calvert elsewhere [Proc. Acad. Nat. Sci. Phil. (1908) 1909, pp. 460–491, pl. xxvi.]. He has since visited Costa Rica, May 1st, 1909–May 9th, 1910, to collect data on (1) the seasonal distribution of the Odonata,

* The Odonata were undertaken successively by Mr. McLachlan and Prof. Karsch, before Prof. Calvert proceeded with the work.

(2) their larval forms, and (3) their habits. An account of his journey was published in the 'Entomological News' for July 1910, pp. 334–337, and this has been followed by other papers on the results of his researches, the most important being the discovery of Odonate larvæ found living in the water which collects between the bases of the leaves of Bromeliads growing upon trees, and of the rearing of the imagines of *Mecistogaster modestus* from these larvæ.

The ten plates belonging to this Volume, of which three are coloured, include figures of 178 species, all but nine appertaining to the Odonata.

[No contributor has been found for the remaining families belonging to the Neuropterous-series in the wide sense, viz. Trichoptera, Neuroptera Planipennia, Mallophaga, Psocidæ, Termitidæ, Embiidæ, and Perlidæ.]

51. ORTHOPTERA. Vol. I.: Forficulidæ by Count de Bormans; Blattidæ, Mantidæ, Gryllidæ, and Locustidæ by Dr. Henri de Saussure, assisted by Dr. Leo Zehntner and A. Pictet.

Five families of Orthoptera are dealt with in this Volume: the Forficulidæ by de Bormans (published in 1893), and the Blattidæ, Mantidæ, Gryllidæ, and Locustidæ by de Saussure (published in 1893–1899). The Introduction, including the systematic list of species figured, was issued in 1900, when Vol. II. of this subject was commenced. De Saussure, in his enumeration, also considered it necessary to describe, notice, or figure various allied South-American or Antillean forms. Under the heading to each family, tribe, &c., he deals with the general classification of the Neotropical fauna, and gives synopses of the genera, and under the genera themselves dichotomous keys to the species. The total number of species recognized as belonging to Central America is 633, of which 224 are new: Forficulidæ 41 (8 new), Blattidæ 156 (60 new), Mantidæ 61 (33 new), Gryllidæ 102 (43 new), Locustidæ 273 (80 new). The twenty-two plates, of which, iii., vi., vii., and viii., are coloured, include figures of 310 species.

52. ORTHOPTERA. Vol. II.: Acridiidæ by Prof. Lawrence Bruner (the subfamily Tettiginæ by A. P. Morse); Phasmidæ by R. Shelford.

This Volume includes the enumeration of the two remaining families of the Orthoptera. The Phasmidæ should have been placed between the Blattidæ and Mantidæ, in Vol. I., but the account of them had to be deferred until the appearance of Brunner v. Wattenwyl's and J. Redtenbacher's Monograph, the concluding portion of which was not published till 1908. Prof. L. Bruner's work on the Acridiidæ, in which Mr. A. P. Morse assisted him with the subfamily Tettiginæ, was issued in 1900–1908, the Tettiginæ having appeared in 1900–1901. The list of the Phasmidæ, published in 1908, was compiled from the above mentioned Monograph, the authors

of which included the material obtained by the Editors of the present work. As in Vol. I., the species, excepting the Tettiginæ, likely to occur in Mexico or Central America are included in the enumeration. Altogether 663 species are regarded as belonging to the fauna, although in many cases, owing to lack of material, there is at present no actual record from within the limits of Central America. The 663 species are apportioned thus: Acridiidæ, including the 26 Tettiginæ, 522 (138 new); Phasmidæ 141. The Index to the two volumes occupies pp. 379–412 in Vol. II. The eight uncoloured plates (four for each family) include figures of 120 species, some of which are Nearctic or Neotropical forms closely related to those known to inhabit Central America.

BOTANY.

53. Vol. I.: by W. B. Hemsley, with a Commentary on the Introduction and Appendix by Sir J. D. Hooker.

This Volume contains the enumeration of the Polypetalæ, Ranunculaceæ–Araliaceæ, which was issued in 1879–1881; the Preface, Introduction, and 'Commentary' appeared in October 1888, on the completion of the entire subject. When this took place, the temporary titlepage and the Index to Vol. I. (pp. 577–619), issued in October 1881, were both replaced in October 1888, the former by a titlepage to include notice of the 'Commentary' by Sir J. D. Hooker, and the latter by a general index for the whole of the four Volumes of text, this appearing in Vol. IV. pp. 333–498, 1887–1888. In the Introduction, pp. ix–lxi (issued in 1888), Mr. Hemsley deals with geographical distribution under the following headings: (1) Statistics of the Phanerogamic Flora of the world; (2) Statistical comparison of the Floras of large and widely separated areas; (3) Generic and specific composition of the Floras of different areas; (4) The distribution of some of the largest Natural Orders; (5) The Primary Botanical regions of the World considered in their relations to the Zoological regions; (6) Comparison of the Zoological with the Botanical regions; (7) Outlying Australian types of vegetation; (8) Botanical division of the earth into primary regions. Sir J. D. Hooker in his 'Commentary on Mr. Hemsley's Introduction and Appendix to the Botanical part of the Biologia Centrali-Americana' (pp. lxii–xlviii) also gives his own views on the Botanical kingdoms, under these headings: (i.) The North Temperate Kingdom of the Old World; (ii.) The Tropical Kingdoms of the Old and New World; (iii.) The three Southern temperate regions (Extratropical America, Africa, and Australia).

54. Vol. II.: by W. B. Hemsley.

The Gamopetalæ, Caprifoliaceæ–Plantagineæ, are dealt with in this Volume. The temporary titlepage and the Index to Vol. II., pp. 577–621, both issued in June

1882, were cancelled in 1888, the "Contents" being added to the title and the Index replaced (as in Vol. I.) by one for the complete series of four volumes, this being inserted at the end of Vol. IV.

55. Vol. III.: by W. B. Hemsley; the Cycadaceæ by W. T. Thistelton-Dyer.

The Incompletæ, Monocotyledones, and Cryptogamic Vasculares, Nyctaginæ–Rhizocarpæ, are enumerated in Vol. III. The Cycadaceæ, pp. 190–195, were studied by Mr., now Sir W. T. Thistelton-Dyer, and his portion of the subject was issued in 1883.

56. Vol. IV.: by W. B. Hemsley.

This Volume, the last of the series, exclusive of that occupied by the Plates. includes: (1) The Supplement to Vols. I.–III.; (2) The enumeration of a small collection of plants made in Cozumel Island in 1885; (3) A list of plants from Holbox, Mugeres, Cozumel, and Ruatan Islands made in 1886; (4) Additions to the list of Costa Rican ferns, bringing the number up to 134; (5) Appendix. The Appendix deals with a variety of subjects: (i.) Preliminary remarks; (ii.) A sketch of the history of the botanical exploration of Mexico and Central America; (iii.) Outlines of the geography and the prominent features of the Flora of Mexico and Central America; (iv.) Summary and analysis of the Flora; (v.) Relationships with the Floras of other regions; (vi.) Further details of the distribution of some of the more prominent natural Orders; (vii.) A specimen of the mountain Flora of South Mexico and Central America; (viii.) Altitudinal distribution of Orchids in South Mexico and the dominating features of the general vegetation; (ix.) Recapitulation of the dominant features of the Flora of Mexico and Central America, and remarks on its probable derivation; (x.) Bibliography. The general index, as stated above, occupies pp. 333–498. The total number of species enumerated in the four volumes is 11,626, of which 196 are indicated as new by the authors.

57. Vol. V.: by W. B. Hemsley.

The 111 Plates (including XLI.*), eighteen of which are coloured, together form Vol. V. of this subject. A complete list of the 144 species figured is given on pp. v–viii. Plate CX. consists of a Map of Mexico and Central America, showing the then known northern limits (in 1887) of the Phanerogamic epiphytes, the Coco-palm, the Marcgraviaceæ, the Vochysiaceæ, and the southern limit of Pines.

ARCHÆOLOGY.

58, 59. Vol. I. (text and plates): by A. P. Maudslay.

The Volume of text contains the Preface and Introduction to the entire subject, and a general account of the ruins at Copan. The latter are described under five headings: (1) Principal Notices and descriptions of the Ruins; (2) Personal narrative; (3) General description of site; (4) Detailed description of principal structures; (5) Description of Stelæ and Altars. In addition to the 119 folio plates, there are numerous illustrations in the text. The text of Vols. I.–IV. is arranged for binding in one Volume; the plates illustrating the subject form four separate volumes, when bound.

58, 60. Vol. II. (text and plates): by A. P. Maudslay.

The Ruins described in Vol. II. are those of Quirigua, Ixkun, Yaxché, Rabinal, Chacujal, Utatlan and Iximché, Mixco (foundation-mounds), and Menché. These places are all shown on the 98 folio plates, the first of which is a map of Guatemala and the adjoining countries, showing the position of the ruins; and there are also various illustrations in the text.

58, 61. Vol. III. (text and plates): by A. P. Maudslay.

The Ruins described in Vol. III. are those of Chichén Itzá and Tikal. The 82 folio plates, the first of which is a map of Yucatan and the country to the south of it, show these places, and there are also three illustrations in the text.

58, 62. Vol. IV. (text and plates): by A. P. Maudslay.

The Ruins of Palenque are described in Vol. IV. under eight headings: (1) Personal Narrative; (2) Principal Notices and Descriptions of the Ruins; (3) General description of the site; (4) Detailed description of the principal structures; (5) Pottery; (6) Initial Series or date; (7) The two-headed dragon; (8) The Water-plant. These subjects are shown on the 93 folio plates.

63. Appendix (text only): The Archaic Maya Inscriptions: by J. T. Goodman.

Pages 1–149 of this Volume are occupied with Mr. Goodman's account of these inscriptions; and pp. 151–264 by the Annual, Chronological, and Perpetual Calendars (Tables), and the Working Chart. The 'Appendix' forms the entire Part VIII. of the Archæology, and is unaccompanied by Plates.

SUMMARY OF CONTENTS OF EACH VOLUME.

		Total number of species.	New species described.	New genera described.	Plates (including maps).	Species figured.	Pages of letterpress.	Dates of issue.
1.	Introductory Volume	..	..	..	10	..	viii & 149	1915
	ZOOLOGY.							
2.	Mammalia	181	..	..	22	34	xx & 220	1879–1882
3.	Aves. Vol. I.	1413	14	1	..	..	xliv & 512	1879–1904
4.	„ Vol. II.						iv & 598	1888–1904
5.	„ Vol. III.						iv & 510	1897–1904
6.	„ Vol. IV.	..	..	..	84	149	vii	1879–1904
7.	Reptilia and Batrachia	695	58	3	76	138	xx & 326	1885–1902
8.	Pisces	415	16	1	28	78	xxxiii & 203	1906–1908
9.	Terrestrial and Fluviatile Mollusca	871	81	1	44	333	xxviii & 706	1890–1901
10.	Arachnida Araneidea	1181 *	417	54	39	981	xv & 317	1889–1902
11.	„ „ and Opiliones.		422 †	38	54		x & 610	1897–1905
12.	Arachnida Scorpiones, Pedipalpi, and Solifugæ	69	8	..	12	37	i & 71	1902
13.	Arachnida Acaridea	55	40	..	21	43	xxi & 55	1886–1893
14.	Chilopoda and Diplopoda	255	106	12	15	139	i & 217	1895–1910
15.	Coleoptera. Vol. I. part 1	1086	384	8	13	324	x & 316	1881–1884
16.	„ Vol. I. part 2	1790	1470	103	19	443	xvi & 824	1882–1887
17.	„ Vol. II. part 1	1629	996	83	19	475	xii & 717	1887–1905
18.	„ Vol. II. part 2	1100	494	19	24	492	xii & 432	1886–1890
19.	„ Vol. III. part 1	1353	805	28	27	648	xvi & 690	1882–1897
20.	„ Vol. III. part 2	813	535	28	13	330	xii & 372	1880–1886
21.	„ Vol. IV. part 1	1776	1295	92	23	568	xxxiv & 572	1884–1893
22.	„ Vol. IV. part 2				21	500	x & 494	1889–1893
23.	„ Vol. IV. part 3	616	516	45	15	397	vi & 354	1889–1911
24.	„ Vol. IV. part 4	1365	1146	69	35	997	viii & 750	1902–1906
25.	„ Vol. IV. part 5	908	717	81	23	720	viii & 514	1906–1909
26.	„ Vol. IV. part 6	605	433	32	14	324	iv & 396	1895–1907
27.	„ Vol. IV. part 7	344	231	17	9	275	vi & 221	1909–1910
28.	„ Vol. V.	1423 ‡	765	57	26	515	xii & 526	1879–1886
29.	„ Vol. VI. part 1	2166	1363	43	43	1010	xx & 625	1880–1892
30.	„ Vol. VI. part 1, Supplement ..						iv & 374	1888–1892
31.	„ Vol. VI. part 2	453	224	4	13	291	x & 250	1885–1894
32.	„ Vol. VII.	602	301	21	13	287	xii & 276	1887–1899
33.	Hymenoptera. Vol. I.	1109	596	21	20	451	xii & 488	1883–1900
34.	„ Vol. II.	711	391	1	14	312	xi & 413	1888–1900
35.	„ Vol. III.	382	66	..	4	57	ii & 170	1899–1900
36.	Lepidoptera Rhopalocera. Vol. I.	1805	376	119	..	..	xlvi & 487	1879–1901
37.	„ „ Vol. II.						iv & 782	1887–1901
38.	„ „ Vol. III.	..	..	..	112	1206	iv	1879–1901
39.	„ Heterocera. Vol. I.	3639	1312	41	..	..	xxxii & 490	1881–1900
40.	„ „ Vol. II.						iv & 622	1891–1900
41.	„ „ Vol. III.	..	..	..	101	1926	iv	1881–1900
42.	„ „ Vol. IV.	973 §	586	54	10	350	xii & 482	1909–1915

* Araneidea 1111, Opiliones 70.

† Araneidea 364, Opiliones 58.

‡ Longicornia 1273 (648 new), Bruchides 150 (117 new).

§ Exclusive of 52 species previously enumerated by Druce in Vols. I. and II.

		Total number of species.	New species described.	New genera described.	Plates (including maps).	Species figured.	Pages of letterpress.	Dates of issue.
	ZOOLOGY (*cont.*).							
43.	Diptera. Vol. I.	977	330	11	6	120	viii & 378	1886–1901
44.	„ Vol. II.	1095	585	40	13	287	x & 490	1888–1903
45.	„ Vol. III.	320	67	1	2	29	viii & 127	1891–1903
46.	Rhynchota Heteroptera. Vol. I.	1108	581	105	39	903	xx & 462	1880–1893
47.	„ „ Vol. II.	607	289	30	22	513	xvi & 416	1897–1901
48.	Rhynchota Homoptera. Vol. I...	323	208	25	13	267	x & 147	1881–1905
49.	„ „ Vol. II. part 1	659	385	42	21	494	xii & 339	1894–1909
49.	„ „ Vol. II. part 2	161	11	2	..	..	ii & 37	1899
50.	Neuroptera: Ephemeridæ	32	8	..	1	9	xxx & 420	1892
50.	„ : Odonata	276	77	1	10	169		1901–1908
51.	Orthoptera. Vol. I.	633	224	14	22	310 *	x & 458	1893–1899 †
52.	„ Vol. II.	663	138	26	8	120 *	viii & 412	1900–1909
	Total	38637	19067	1373	1173	18051	.....	1879–1915
	BOTANY.							
53.	Vol. I.	11,626	22	..	..	..	lxviii & 576 ‡	1879–1888
54.	„ II.		135				iv & 576 ‡	1881–1888
55.	„ III.		34				iv & 711	1882–1888
56.	„ IV.		5				iv & 498	1886–1888
57.	„ V.	..	..	..	111	144	viii	1879–1888
	ARCHÆOLOGY.							
58.	Vol. I. (text)	..	..	..	..	..	viii & 69	1888–1902
58.	„ II. (text)						iv & 47	1899–1902
58.	„ III. (text)						iv & 50	1895–1902
58.	„ IV. (text)						iv & 38	1896–1902
59.	Vol. I. (plates).....	..	..	..	119	..	iv	1889–1902
60.	„ II. (plates).....	..	..	..	98	..	iv	1899–1902
61.	„ III. (plates).....	..	..	..	82	..	iv	1895–1902
62.	„ IV. (plates).....	..	..	..	93	..	iv	1896–1899
63.	Appendix (text only).....	..	..	..	..	..	xii & 264 §	1897

* Including allied South- or North-American or Antillean forms figured for comparison.

† The Introduction, including the systematic list of species figured, was not issued till April 1900, when Vol. II. was commenced.

‡ The Index (pp. 577–619 of Vol. I. and pp. 577–621 of Vol. II.) was replaced, on the completion of Vol. IV., by a fresh one for all four volumes, which is placed at the end of IV.

§ Calendars, pp. 151–264, not paged.

SIX maps, in addition to the eight included in the Introductory Volume, have been issued in various volumes of the present work: two, showing the "Distribution of Freshwater Fishes in Mexico and Central America" (Pisces, Introduction, 1908); one, illustrating the Distribution of pines, coco-palm, etc. (Botany, Vol. V., plate 110); one, giving the "Actual Distribution of Mean Annual Temperatures," illustrating the distribution of the Odonata (Neuroptera, Introduction, 1908); one of Guatemala and the adjoining countries, showing the position of the ruins in Mexico, Guatemala, and Honduras, described by Mr. Maudslay (Archæology, Vol. II., plate 1); and one of Yucatan and the country to the south of it, showing the position of other places described by the same author (Archæology, Vol. III. plate 1).

ORIGIN, ETC., OF THE FAUNA AND FLORA OF CENTRAL AMERICA.

[The following summary and conclusions on the origin and geographical distribution of the Mammalia, Reptilia, Batrachia, Pisces, Arachnida, Chilopoda, Diplopoda, and Prototracheata of Central America, and the faunistic divisions of the region, have been kindly supplied by Messrs. R. I. Pocock and C. Tate Regan; and Mr. W. B. Hemsley has given us a similar account of the Flora. These valuable contributions are based upon our present knowledge of the subject, bringing the account up to date. As regards the Insecta, which occupy so large a portion of the work, no satisfactory conclusions can be formed till they have been more thoroughly collected and studied in other tropical regions, and perhaps till we know more of them in a fossil state.—Ed.]

FAUNA.

MAMMALIA.

By R. I. Pocock, F.R.S.

Since the publication of Mr. E. R. Alston's volume on the Mammalia of Central America in 1882, great advances have been made in our knowledge of the subject. The past history of many of the orders and families has been more or less accurately ascertained by palæontological research, principally in the United States and in the Argentine; and the modern methods of collecting and preserving existing material have led to the discovery of large numbers of genera, species, and subspecies, and in addition have thrown such light upon the vertical and horizontal distribution of American Mammals, as a whole, that it has become possible to map their zones and provinces with much greater precision.

This progress in accuracy of information has been accompanied by a gradual change in the conception of systematic terms, with the result that what our predecessors ignored as "local varieties" are now regarded as "species" and, by a logical sequence, the old-time species are being given the rank of genera. Quite apart, too, from the names that have been introduced to designate new forms, considerable changes have taken place in the nomenclature of long-established species and genera. Opinions may differ as to the advisability and advantage of the alterations coming under these headings, but they have to be admitted and dealt with by faunistic and systematic workers.

In view of the additions and modifications thus briefly referred to, it is necessary to gather together the principal records that have been published during the last quarter of a century concerning the Mammals of Central America *. The plan adopted will be to treat the orders separately and to append to each a brief account of its palæontological history and such particulars of its distribution as have a bearing on the matter in hand.

Order PRIMATES.

The American Monkeys (Cebidæ) and Marmosets (Callitrichidæ) constitute the Platyrhine tribe of Primates as opposed to the Catarhine tribe embracing the Monkeys, Apes, and Men of the Old World. The Central American species belong to genera inhabiting also South America, where they are restricted to the forested districts east of the Andes, most of them being of tolerably wide range within those limits. In Central America they are similarly limited to the forest. Of the Cebidæ, Squirrel Monkeys (*Saimiri*=*Chrysothrix*) extend to Costa Rica, Spider-Monkeys (*Ateles*), and Howlers (*Alouatta*) to Vera Cruz in Mexico, Capuchins (*Cebus*) to Nicaragua, and Douroucoulis (*Aotus*=*Nyctipithecus*) to Costa Rica and Nicaragua, but the latter locality needs confirmation. Of the Callitrichidæ, Geoffroy's Tamarin (*Œdipomidas geoffroyi*) ranges from Colombia to Costa Rica.

There are no Monkeys in the Antilles, apart from introduced species, and none in North America.

There is a good deal of evidence that Monkeys are the descendants of Lemurs, which date back to the Lower and Middle Eocene of North America and Europe, and survive at the present time in Africa, Madagascar, and Southern Asia. Oddly enough, this group of Primates never seems to have entered South or Central America, and no fossil remains of Monkeys have been found in North America. Nevertheless, Platyrhine Monkeys go back to the Upper Miocene in South America if the reference of *Homunculus* to that group be, as it appears to be, correct, and no extinct members of the group (which is, as a whole, more Lemuroid than the Old World Catarhini) have been found outside that continent. There are one or two facts which suggest Africa as their original home.

In Madagascar there has been found an extinct Lemur (*Archæolemur*) which is claimed to have Platyrhine characters in its jaws and teeth, and the Oligocene of Egypt has yielded a Monkey (*Parapithecus*) structurally bridging the interval between existing Lemuroids of the Tarsioid (*Tarsius*) group and the Simiid or monkey-like Primates. If the interpretations put upon these fossils be correct, it seems that the transitional stages between the Lemurs and the Monkeys were probably evolved in an Afro-Mascarene

* It is perhaps necessary to explain in this connection that here and elsewhere in this article the term "Central America" is used comprehensively, as it is used in the title of the 'Biologia,' to embrace the area lying between, and including, Mexico and Panama, Lower California being excluded.

continent. Coupling this inference with the absence of extinct Monkeys in North America and of Lemurs in South America, the view that the ancestors of the Platyrhini entered South America from Africa is at all events provisionally defensible.

Order INSECTIVORA.

America is not rich in members of this order. Two families, the Talpidæ (Moles) and Soricidæ (Shrews), occur in North America. Although the Talpidæ range as far south as the Southern States, they do not appear to enter Mexico or Central America. The Soricidæ, on the contrary, are represented in Central America by the three genera *Sorex*, *Cryptotis* (sometimes regarded as a subgenus of the North American *Blarina*), and *Notiosorex*. Of these, *Sorex* has a wide range over Europe, Asia, and North America, and passes at high altitudes through Mexico to Guatemala; *Notiosorex* inhabits the Southern States of North America (Texas etc.) and Mexico (Sinaloa, Jalisco). *Cryptotis*, which replaces in Central America the North American genus *Blarina* *, ranges mostly at high altitudes through Central America (Mexico, Yucatan, Guatemala, Nicaragua, Costa Rica) to Colombia, Venezuela, and Guiana.

Shrews related to *Sorex* and *Blarina* have been recorded from the Oligocene of Europe and North America, and *Sorex* itself goes back to deposits of that age in Europe, appearing in North America in the Pleistocene, and since no Insectivores of this group occur in South American deposits †, it seems clear that the Central American species are southern migrants from North America.

Order CHIROPTERA.

The Central American genera of this order, fifty or more in number, are assigned to eight families—the Emballonuridæ, Noctilionidæ, Phyllostomidæ, Desmodontidæ, Natalidæ, Thyropteridæ, Vespertilionidæ, and Molossidæ ‡. Geographically these families may be referred to two categories: the first containing the Vespertilionidæ, Molossidæ, and Emballonuridæ, which are represented in the Old World as well as in America; and the second containing the remaining five, which are mostly restricted to Central and South America, a few genera only occurring in the Southern States of North America. Of this second category, by far the most important numerically are the Phyllostomidæ, the American Leaf-nosed Bats §, the genera of which, occurring in

* A species of *Blarina* has been recorded from Costa Rica, but there seems to be some doubt about the correctness of the locality.

† The only extinct South American Insectivore known is *Necrolestes* of Upper Miocene age, the nearest ally of which appears to be the Golden Mole (*Chrysochloris*) of South Africa.

‡ Pending the completion of Dr. Knud Andersen's 'Monograph of the Chiroptera,' in course of publication by the Trustees of the British Museum, the classification and nomenclature here followed are those of Miller (Bull. U.S. Nat. Mus. lvii. 1907).

§ The Leaf-nosed Bats of the families Rhinolophidæ, Hipposideridæ, and Megadermidæ are restricted to the Old World.

Central America, are about equal numerically to the genera of all the other families put together.

A few only of the more important genera need be mentioned.

The Vespertilionidæ are cosmopolitan to the limit of tree-growth. Three familiar Old World forms occurring in our area are: *Myotis*, extending from North America to the Argentine; *Eptesicus*, spreading as far south in America as Guatemala; and *Pipistrellus*, reaching South Mexico. *Corynorhinus*, the American representative of the Old World *Plecotus*, ranges from North America into Mexico. Other American genera are: *Dasypterus*, extending from North to South America; *Rhogoëssa*, from Central Mexico to Venezuela; and *Bœodon*, known only from Jalisco, in Mexico. Finally, *Antrozous*, formerly, but wrongly, affiliated with *Plecotus* and ranging from the Southern States of the Union to Central Mexico, constitutes with the Australasian genus *Nyctophilus* a special subfamily of the Vespertilionidæ.

The Molossidæ are more southern in distribution than the Vespertilionidæ. In the Old World their northern limit is South Europe and Asia. One genus only, *Nyctinomus*, found also in Europe, Africa, Asia, and Australia, reaches America, where it spreads from the Southern United States, though Central America, to Chili. Of exclusively American genera, *Promops* and *Molossus* pass from Mexico into South America, while *Eumops* has a northern range into the Southern States.

Of the Emballonuridæ, mainly a tropical family, not one of the Old World genera occurs in America, and the American genera (e. g. *Saccopteryx*, *Peropteryx*, and *Diclidurus*) extend from Central into South America.

Of the families confined to America, the Noctilionidæ contains two genera—one South American, the other (*Noctilio*) passing northwards to South Mexico; the Natalidæ and Thyropteridæ contain one genus each, namely *Natalus* and *Thyroptera*, ranging respectively from South America to Central Mexico and Honduras; the Phyllostomidæ, divisible into several subfamilies, have, broadly speaking, a distribution similar to that of the other exclusively American families just mentioned, though some of the genera have a wider, others a narrower, range. For example, of the Chilonycterinæ, *Mormoops* reaches Texas, *Chilonycteris* and *Pteronotus* do not go north of Mexico; of the Phyllostominæ *Xenoctenus* is only known from Costa Rica, *Glyphonycteris* passes southwards from that country to Peru, whereas *Otopterus* extends from the Southern States of North America to Guatemala; of the Glossophaginæ, *Chœronycteris* reaches from South America to Arizona. The single species of *Halonycteris* is known only from Costa Rica, while *Lichonycteris*, also monotypical, has been recorded from Nicaragua and Guiana. Similarly, in the Stenoderminæ, the monotypical *Centurio* and *Ectophylla* are Central American, but the other Central American genera range into tropical South America. Finally, the family Desmodontidæ, or true Vampyres, differing from the Phyllostomidæ by their large shear-like anterior teeth, is represented by two genera, *Desmodus* and *Diphyllus*, which are distributed from Southern Mexico to Paraguay and Brazil.

The small number of extinct Chiroptera known, *i. e.* a few genera belonging to the Hipposideridæ and Vespertilionidæ from Eocene and Oligocene deposits of Europe, throw no light upon the present distribution of the order.

Order RODENTIA.

In the number of species and genera inhabiting Central America, this order rivals, if it does not surpass, the Chiroptera, the four usually admitted suborders (Sciuromorpha, Myomorpha, Hystricomorpha, and Lagomorpha *) being well represented.

Suborder SCIUROMORPHA.

Two families of this suborder have to be considered, namely the Petauristidæ or flying Squirrels and the Sciuridæ or true Squirrels, Ground-Squirrels, and Marmots. The one American genus of Petauristidæ, *Sciuropterus*, ranges from Europe and Asia into North America, where it extends from Alaska to Guatemala. Of the Sciuridæ, the Chipping Squirrel (*Eutamias*) and the Souslik (*Citellus*) have a distribution as extensive as that of *Sciuropterus*, whereas an allied form, *Callospermophilus*, and the Prairie Marmot (*Cynomys*) are restricted to the South and Western States of North America and North Mexico. True arboreal Squirrels are represented by vast numbers of species and subspecies in North, Central, and South America, as well as in Europe, Asia, and Africa; but the genera and subgenera to which they have been referred require revision and re-definition before their mutual affinities can be accurately ascertained. Of the Central American genera, *Sciurus* (s. s.) appears to be the only one that occurs in the Old World, where it ranges from Japan to Ireland. In America it is generally distributed throughout the States, occurs everywhere in Central America at high and low levels, and enters the northern countries of South America (Colombia, Ecuador). An allied form with many species, *Guerlinguetus* (*Parasciurus*), is credited with a range from the United States to Peru. Others that may be mentioned are *Baiosciurus* (extending from Mexico to Nicaragua), *Syntheosciurus* (known only from Chiriqui in Panama), and *Microsciurus* (alleged to spread from Costa Rica to Peru †).

Genera regarded as primitive Sciuromorphs were abundant in North America (Ischyromyidæ) and Europe (Pseudosciuridæ) during early Tertiary times (Eocene and Oligocene), extinct Marmots (*Palæarctomys*) and the still existing *Cynomys* have been traced back to the Upper Miocene in North America, while *Sciurus* itself has survived in Europe and North America since the Upper Oligocene. Since no extinct forms are

* Apart from the Lagomorpha, these suborders are not perhaps susceptible of precise definition. They are here maintained for the sake of convenience.

† Beavers (Castoridæ) should perhaps be added to this section, since they range in North America at least as far south as Sonora. In the Old World, Beavers occur in Northern Asia and North and Central Europe.

known in South America, unless of quite recent date, it seems clear that Central America received this prominent element of its fauna from North America.

Beavers also seem to have originated in North America, where they date back to the Middle Oligocene, but *Castor* itself appeared in Europe in the Pliocene and in North America in the Pleistocene.

Suborder MYOMORPHA.

The Central American Myomorphs belong to the three families Muridæ, Heteromyidæ, and Geomyidæ, the two last-named being restricted to America.

The genera of Muridæ belong to the three subfamilies Microtinæ, Neotominæ, and Cricetinæ. Of the Microtinæ, *Microtus* (s. s.) extends over the greater part of Europe, Asia, and North America, and enters Mexico (Puebla, Jalisco, Oaxaca). Two subgenera are known only from Central America, namely, *Orthriomys* from Oaxaca and *Herpetomys* from Guatemala, both at high altitudes. The other genus *Pitymys* has a singular distribution, ranging in the Old World from South and Central Europe to Asia Minor (the Mediterranean Area), and through the Eastern States of North America to Mexico (Vera Cruz).

Of the Neotominæ, *Xenomys*, *Hodomys*, *Nelsonia*, and *Teanopus* are confined to Mexico, while *Neotoma*, represented by a host of species, overlaps them to the north and south with a range from the Southern States of North America to Guatemala.

The Cricetinæ have an extraordinarily wide distribution, namely Africa, including Madagascar, Europe, Asia, and practically the whole of America. The Central American genera are too numerous to mention in detail. Some occur in North and Central America, others in Central America alone, others are common to Central and South America, while others extend over the three areas mentioned. To the last category belong *Reithrodontomys*, *Oryzomys*, and *Sigmodon*, ranging from the Southern States of the Union to Ecuador, Chili, and Peru, respectively. As examples of the first group may be cited *Peromyscus* (*Hesperomys*) distributed from Labrador to Panama, and *Baiomys* and *Onychomys* from the Southern States to Guatemala and Panama. Peculiar to Central America are *Nyctomys* and *Ototylomys*, ranging from Mexico to Panama and Guatemala, and *Sigmodontomys* known only from Costa Rica, while *Akodon*, extending all over South America from Costa Rica, and *Nectomys*, occurring in Nicaragua, Ecuador, and Colombia, are representatives of genera common to Central and South America.

The genera of Heteromyidæ belong to two subfamilies, the Heteromyinæ and Dipodomyinæ. Of the latter, *Perodipus* and *Dipodomys* (Jerboa-Mice) are restricted to the South and South-western States of North America and to Mexico (Zacatecas, Vera Cruz, etc.). Of the former, *Heteromys*, *Perognathus*, *Liomys*, and *Chætodipus* occur in the Southern United States and Mexico, the first passing southwards into

Colombia and Venezuela. The Geomyidæ, or Pocket-Gophers, are mainly Central American, *Thomomys*, *Cratogeomys*, and *Geomys* ranging into the Southern States of the Union, *Platygeomys*, *Zygogeomys*, etc., being Mexican, *Orthogeomys* extending from Mexico to Guatemala, and *Macrogeomys* occurring from Nicaragua to Panama.

The palæontological history of the Voles (Microtinæ) before the Pleistocene is somewhat meagre, but *Microtus* has been traced back to the Pliocene in Europe and to the Pleistocene in North America. Records of the Cricetinæ are more complete, and extend back to the Lower, Middle, and Upper Oligocene in Europe and North America, the existing *Peromyscus* dating in North America to the Miocene. In South America Cricetines appear to be of recent (Pleistocene) date. The Heteromyidæ and Geomyidæ, closely related families, seem to have originated in North America, where they have been traced respectively to the Lower and Upper Oligocene.

The palæontological evidence, therefore, suggests that the ancestors of the Central and South American Myomorpha came down from the north. This is no doubt true of the Geomyidæ and Heteromyidæ, but it is not so certain of all the Cricetines. The failure to discover fossil remains of small rodents such as these in mid-Tertiary (Upper Miocene) deposits in South America cannot be regarded as conclusive evidence of their absence there at the time the deposits were laid down; moreover, the occurrence of genera of this subfamily in Madagascar strongly suggests their existence in Africa at a sufficiently early date to permit their migration thence into South America by the land-connection which there are other grounds for thinking may have joined these two continents together.

Suborder HYSTRICOMORPHA.

Three families—the Octodontidæ, Dasyproctidæ, and Hystricidæ—occur in Central America, but neither is peculiar to the country, though the Dasyproctidæ are found elsewhere only in South America and the West Indies. None of the Central American genera of these families enters the United States.

Of the Dasyproctidæ, *Dasyprocta* (Agouti) ranges from Brazil through Panama to Mexico, probably Vera Cruz; *Agouti* or *Cœlogenys* (Sooty Paca) also passes from Panama to Vera Cruz. The Hystricidæ are represented by *Coendou* (= *Synetheres*), the common South American Tree-Porcupine, which extends from Bolivia and Brazil to the mountains of Mexico. In North America its place is taken by *Erethizon*, distributed from Alaska and Canada to Arizona. One other genus of this family, *Chætomys*, occurs in South America only. These arboreal Porcupines constitute the subfamily Erethizontinæ as opposed to the Hystricinæ or Ground-Porcupines of the Old World. The Octodontidæ, generally distributed throughout South America, comprises a large number of genera, two of which, *Loncheres* and *Proechimys*, enter Central America, the latter as far as Nicaragua, the former only to Panama. A third, *Hoplomys*, occurs in both these countries.

Although South America must be regarded as the present headquarters of the Hystricomorphs, on account of the number and diversity of the genera that occur there, the group is not restricted to America. There are several African genera belonging to or closely allied to the Octodontidæ; and Porcupines (*Hystrix*, *Atherura*) are found in Tropical Asia as well as Africa.

The palæontological history of the Hystricomorphs is very different from that of the other suborders of Rodentia. Genera regarded as ancestral members of the group, and constituting the family Theridomyidæ, were living in Europe from the Middle Eocene to the Upper Oligocene, and true Porcupines, related to the existing species of *Hystrix*, were in Europe in the Middle Miocene; but none of these extended into North America. On the other hand, genera assignable to the Octodontidæ and Erethizontine Porcupines suddenly appear in South America in Upper Miocene deposits—that is to say, considerably later than the date of the first known appearance of the group in Europe. The available evidence therefore points to the conclusion that this suborder made its way into South America from Africa, and subsequently spread northward into Central America and into North America, *Erethizon* dating from the Pleistocene in the latter country.

Suborder LAGOMORPHA.

The Ochotonidæ (Picas)—which occur in Central Asia and spread through Western North America from Alaska to California, Utah, and Montana—do not enter Mexico. The Leporidæ have a much wider range. Three genera have been recorded from Central America, namely *Lepus*, *Sylvilagus*, and *Romerolagus*. The last is monotypical, and has been discovered at Puebla, Popocatepetl, etc., in Mexico at a height of 10,000 to 12,000 feet. *Sylvilagus* runs right through Central America from the Southern United States into South America. *Lepus*, in the modern sense, on the other hand, does not go south of Mexico (Durango, Tamaulipas, Potosi, etc.), whence it spreads northwards to Greenland and is also found in Asia, Europe, and Africa.

The earliest palæontological records of Hares (Leporidæ) are from the Lower Oligocene of North America (*Palæolagus*). *Lepus* itself was in existence in the Upper Oligocene of that continent, and appeared in Europe in the Lower Pliocene. It seems therefore that this suborder of Rodents was evolved in North America, and thence made its way into the Old World and into Central and South America.

Order CARNIVORA.

The terrestrial or fissiped Carnivores of Central America belong to the five families Canidæ, Procyonidæ, Ursidæ, Mustelidæ, and Felidæ.

Canidæ:—The genus *Canis* is represented in North America by many species or local races belonging to groups typified by *C. occidentalis* and *C. latrans*, corresponding

respectively to the Wolves and Jackals of the Old World. Both groups occur on the Mexican plateau—distinct species of the *latrans* or Prairie Wolf type having been recorded from Tamaulipas, Durango, Puebla, etc., as far as Guatemala, and an unknown form is said to occur in Costa Rica. A second genus, *Urocyon*, commonly regarded as a Fox, extends from the Eastern States of North America, through Central America (Mexico, Yucatan, Guatemala), to Colombia in South America.

There are reasons for thinking that *Urocyon* is more nearly allied to the South American group of Canidæ typified by *Cerdocyon thous* than to *Vulpes*. If this be so, the genus constitutes an interesting geographical link between the Canidæ of North America and those of South America. In the latter continent there is a very large number of species ranging from the extreme north to Cape Horn and the Falkland Islands. These are referable to several groups possibly of generic status; but none of these can be definitely affiliated with *Canis* or *Vulpes* or other genera inhabiting North America and the Old World. The apparent absence from the tropical countries and highlands of Central America of Canidæ related to the forest and Andean species of South America is a singular fact.

Mustelidæ.—The dominant Central American Mustelids appear to be Skunks, which are represented by *Mephitis* ranging from Canada to Guatemala, *Spilogale* from the Southern United States through Mexico to Costa Rica, and *Conepatus* with much the same northern limits as *Spilogale*, but extending throughout South America to Tierra del Fuego, mostly at high levels. Weasels (*Mustela*) range all over Europe, Central and Northern Asia, North America, and thence southwards through Central America into the northern countries of South America. The remaining terrestrial forms, the Tayra (*Tayra* = *Galera*) and the Grison (*Grison* = *Galictis*), are more southern in distribution. The former is found in Vera Cruz, Nicaragua, Panama, Guiana, Peru, Brazil, etc., and the latter in Honduras, Yucatan, Costa Rica, and thence southwards to Patagonia. Finally, Otters (*Lutra*) are represented in Cental America by two species, one described from Jalisco, the other from Nicaragua. This genus is practically cosmopolitan in the Old World, apart from Madagascar and the Australian Region, its exceptionally wide range being possibly connected with independence of terrestrial barriers resulting from its power of making its way by swimming along coast-lines.

Felidæ.—Cats are abundant everywhere, and belong to many distinct groups, probably of generic value. The short-tailed or Lynx-group, which is widely distributed over Northern Europe, Asia, and North America, enters Mexico (Tamaulipas, Sinaloa). The Puma-group, which has no close kinship with Lions and Leopards of the Old World, ranges from the confines of Canada to Patagonia and occurs in Central America at both high and low levels from Mexico to Panama. The other species of this family—belonging to a variety of groups akin to the Jaguar (*F. onca*), Ocelot (*F. pardalis*), Eyra (*F. eyra*) groups, etc.—are related to the South American species of those

names. Both Ocelots and Jaguars frequent the forested districts of South America, and pass through Central America into the United States north of Mexico. There is no doubt that the Jaguar is closely allied to the Leopards, and is the only American member of the genus which comprises also the Lion, Tiger, Leopard, and Ounce of the Old World. Ocelots, too, are not apparently generically separable from several of the Eastern Asiatic species, and there appears to be a form closely akin to them in tropical West Africa.

Procyonidæ.—The five admitted American genera of this family occur in Central America, which in this respect is richer than either the northern or southern moieties of the New World. *Procyon* (Raccoon) has a range almost equal to that of the Puma in its extension from near the borders of Canada to Paraguay. Subspecies akin to the typical North American form (*lotor*) reach Southern Mexico; two species appear to be restricted respectively to Yucatan and Panama, while the South American *P. cancrivorus* enters the latter State. A peculiar species of *Nasua* (Coaiti Mondi) occurs on Cozumel Island, Yucatan, the rest of the Central American forms recorded from Mexico (Colima, Chihuahua), Yucatan, Guatemala, and Panama being regarded as subspecies of the South American *N. narica*; *Bassariscus* (Cacomistl) ranges from Texas and Oregon through Mexico to Guatemala and Panama; *Bassaricyon* is represented by species from Nicaragua, Costa Rica, and Panama, and occurs as far south as Ecuador; while *Potos*, better known as *Cercoleptes* (Kinkajou), ranges from Mexico (Vera Cruz) Costa Rica, and Guatemala into Colombia, Ecuador, Venezuela, etc.

In the Old World the family is represented by *Ælurus* (Panda) of the Eastern Himalayas and probably by *Æluropus* of Moupin in Eastern Tibet. The latter, however, is claimed by some authorities to be Ursine in its affinities. It shares the characters of the Ursidæ and Procyonidæ, and may perhaps be regarded as the living link between the two families.

Ursidæ.—Bears akin to the North American Black Bear (*Ursus* (*Euarctos*) *americanus*) extend into Mexico as far as Coahuila and Chihuahua. South of Mexico the family is unknown in Central America; but it reappears in the northern Andean district of South America, where a genus (*Tremarctos*), distinct from *Ursus*, is now found—and this genus, oddly enough, also appears to contain the Central Asiatic Black or Tibetan Bear, which ranges from Baluchistan through the Himalayas to Japan.

The palæontological history of the families of Central American Carnivora need not be discussed in detail. The evidence, incomplete in details though it be, shows that they are without exception descended from northern forms that inhabited North America or Europe or both continents during Middle or early Tertiary times, the Canidæ dating back to the Upper Eocene, the Procyonidæ to the Lower Miocene in North America, the Ursidæ to the European Upper Miocene where they apparently blend with the

Canidæ, the Mustelidæ to the Lower Oligocene, and the Felidæ *, even *Felis* itself, to the Middle Miocene of Europe and North America. No extinct forms so early in time have yet been discovered in South America. Hence it is needless to look beyond North America for the immediate origin of the Central American and South American forms. But no data, palæontological or otherwise, seem to have been discovered as yet to explain the almost complete absence of Canidæ from the southern countries of Central America and the discontinuity in the distribution of the Bears above alluded to. Nor in the case of such genera as *Galera*, *Grison*, *Nasua*, and others is it clear whether their presence in Central America is due to northward migration from South America, or whether it is attributable to their settlement in the former area on their way to the southern continent.

Order ARTIODACTYLA.

The Bunodont or non-ruminant Artiodactyls are represented in America by the family Tayassuidæ (formerly Dicotylidæ), commonly known as Peccaries. The described species may be referred to two categories, regarded sometimes as genera, exemplified by the Collared Peccary (*Tayassu tajacu* = *torquatus*) and the White-lipped Peccary (*T. pecari* = *labiatus*). Species of the former category range from Texas (Guadalupe) to the Argentine, and have been recorded from Mexico (Sonora, Colima, Puebla), Guatemala, and Panama; those of the second category spread from Campeche to Paraguay.

Three families of ruminant Artiodactyls inhabit Central America, namely the Bovidæ, Antilocapridæ, and Cervidæ. The first two, represented by the Bison (*Bison*), the Rocky Mountain Sheep (*Ovis*), and the Prongbuck (*Antilocapra*), are essentially North American. The Bison inhabited Mexico in historic times. The Sheep and the Prongbuck penetrate Mexico as far as Chihuahua. The Cervidæ or Deer belong to two genera—*Odocoileus*, which extends from the United States, through Mexico to Panama, and thence into South America, and *Mazama*, ranging from Mexico (Vera Cruz) and Yucatan to Brazil and the Northern Argentine.

The palæontological history of the Peccaries is fairly well known, many genera of the family having been discovered in the North American Tertiaries, dating from the Lower Oligocene. But our knowledge of the descent of the ruminant Artiodactyla is singularly meagre in the matter of details. The Central American Cervidæ (*Odocoileus*, *Mazama*) belong to a group of the family (Telemetacarpalia) which, with a few exceptions, is confined to America. Possibly they are descended from a form (*Blastomeryx*) which existed in North America in the Lower Miocene. *Odocoileus* itself goes back to the North American Pliocene, but it seems difficult to avoid the

* Excluding the extinct Oligocene Machærodonts, which have been recently claimed as their ancestors.

conclusion that *Mazama*, typically a South American genus, is a more primitive type, unless it be degenerate, in its simple one-spiked antlers. Nevertheless, the absence of extinct Deer in South America, except in late Tertiary (Pleistocene) deposits, precludes at present the view that the family was evolved in that country and subsequently made its way northwards.

The Antilocapridæ are not certainly known from deposits in North America older than the Pleistocene, and none have been discovered elsewhere. Possibly the North American mid-Miocene genus *Dromomeryx* was the ancestral form.

The oldest-known forms of Caprinæ (*Ovis*) and Bovinæ (*Bison*) are European. The Bovinæ do not appear to be definably distinct from the so-called Tragelaphine Antelopes, which in Europe go back to the Upper Miocene. A Caprine (*Cridotherium*) is of that date also. Hence it appears that the Artiodactyle Ungulates of Central America must be regarded as of northern descent.

Order PERISSODACTYLA.

Of the existing families of this order only the Tapiridæ occur in Central America, where they are represented by two species of the genus *Tapirella* (*Elasmognathus*), namely *bairdi*, ranging from South Mexico to Panama, and *dowi*, from Guatemala to Nicaragua and Costa Rica. The Tapirs of South America, where they extend from Venezuela to the Northern Argentine, are referred to a distinct genus, *Tapirus*. Outside Tropical America the family contains but one representative, namely, *Rhinochœrus indicus*, from the Malay Peninsula and Sumatra.

Tapirs referred to a variety of genera inhabited North America from the Lower Eocene and Europe from the Lower Oligocene. There are gaps in the genealogy of the recent forms, but species akin to them have been discovered in Pliocene deposits in Europe and Asia and possibly in contemporaneous beds in North America. From this it seems tolerably clear that the existing genera are the survivors in the East Indies and in Tropical America of a family formerly widely distributed in the Northern Hemisphere.

Order SIRENIA.

One genus of this order, the Manatee (*Trichechus* = *Manatus*), occurs in the rivers of eastern Central America and South America. It also inhabits some of the rivers of Western Africa, but is not found elsewhere.

There is evidence that the Sirenia were evolved in North Africa from the stock that also gave rise to the Proboscidea. Genera of Eocene age have been discovered in Egypt and also in the West Indies. Although *Trichecus* itself is only known as an existing genus, its presence in rivers and estuaries on the eastern and western shores of the Atlantic and its avoidance of the open sea have been cited as evidence of a continuous coast-line between Africa and Tropical America.

Order EDENTATA.

Eliminating the Old World genera *Orycteropus* and *Manis*, this order is confined to South and Central America. *Cholœpus* and *Bradypus*, the two genera of Sloths or Bradypodidæ, pass from South into Central America, the former as far as Costa Rica and the latter to Nicaragua. *Myrmecophaga* and *Cyclopes*, two of the Anteaters (Myrmecophagidæ), also go as far as Guatemala; the third genus, *Tamanduas*, extends northward to Tabasco and Vera Cruz in Mexico. Of the large number of South American genera of Armadillos (Dasypodidæ) two only enter Central America, namely *Cabassous* (*Lysiurus*), which ranges from Brazil to Honduras, and *Dasypus* (=*Tatu* or *Tatusia*), which overlaps it both to the north and south, with an extension from the Argentine to Texas, just touching the latter state at Brownsville.

The origin and centre of evolution of the Edentata is at present unknown. The only extinct forms that have been claimed to be their ancestors are the Tæniodonts or Ganodonts of the Eocene of North America. Since this view has been authoritatively disputed, it needs no further consideration here. Of more importance, from our present point of view, is the mid-Eocene North American genus *Metacheiromys*, believed by some to be a primitive Armadillo. It is true that the Armadillos (Dasypodidæ) are the least specialised of all undoubted Edentates, living or extinct, and no reason can be alleged against the likelihood of the discovery of an early type in the Eocene of North America, but since *Metacheiromys* unfortunately has few, if any, of the characters distinctive of Edentates as we know them, it cannot be maintained as established that the order is of North American origin. It may be suggested that their ancestors entered South America from Africa. However that may be, the evidence of fossil forms shows that South America has been the centre of evolution of the large number of existing and extinct genera that have been discovered. In South America, Armadillos (Dasypodidæ) date back to the Upper Miocene, the Dasypodinæ (*olim* Tatusiinæ) themselves, which are now found in Central and North America, ranging from that date to the Pleistocene. Hence the presence of *Dasypus* in Central America and Texas must be assigned to northward migration. And the same must be claimed of the Sloths (Bradypodidæ) and Anteaters (Myrmecophagidæ). No extinct forms of these families have yet been discovered, but abundant remains of a wholly extinct group, intermediate in many respects between the two, but less specialised than either, have been discovered in South American Miocene and later deposits. These are the Ground-Sloths (Mylodontidæ and Megatheriidæ), which at a later date (Pliocene and Pleistocene) lived also in North America.

Order MARSUPIALIA.

The American Marsupials belong to two families, the Didelphyidæ (or Opossums) and the Cænolestidæ. The latter, represented by the two existing species of *Cænolestes*

from Ecuador and Colombia, does not appear to reach Central America; but no fewer than five genera of the former occur in our area, namely *Didelphys*, *Metachirus*, *Caluromys* (=*Philander*), *Marmosa*, and *Chironectes*. Of these *Didelphys* is the only one that is found in North America, where it ranges from about the 40th parallel of N. lat. to Texas, thence passing southwards through Mexico, Nicaragua, Yucatan, Guatemala, and Panama as far as the Argentine and Chili. The others are Central and South American, *Marmosa* ranging from Mexico (Oaxaca), Costa Rica, and Panama to Chili, *Metachirus* from Mexico (Vera Cruz), Guatemala, and Costa Rica to the Argentine, *Caluromys* from Mexico (Tabasco) to Paraguay, and *Chironectes*, the aberrant water-opossum, from Guatemala to Brazil.

Extinct Marsupials belonging to the Didelphyidæ, and closely related to the existing genera of that family, have been discovered in Lower Eocene deposits in North America and as late as the Lower Miocene in Europe, and in what are believed to be Upper Cretaceous beds in South America. Formerly, therefore, the family was very widely distributed. Nevertheless, Opossums appear to have survived uninterruptedly in South America, at all events since the earliest Tertiary times, and that country is now their headquarters. These facts, coupled with the absence of palæontological evidence that the group survived in North America after the Oligocene and in Europe after the Miocene, justify the supposition that the existing genera are recent immigrants from South into Central and North America.

SUMMARY AND CONCLUSION.

Origins of the Central American Mammalian Fauna.

The foregoing account shows that the Mammalian fauna of Central America is a mixture of two elements, namely, of forms which are dominant in North and South America respectively; and the palæontological history, during Tertiary times, of the orders concerned, supplies—in part, at all events—the explanation of the intermixture. So far as this history has been read, it furnishes strong evidence that the Mammals may be referred to two categories. To the first belong the Insectivora, Carnivora, Artiodactyla, Perissodactyla, and the Rodentia (with the exception of the Hystricomorphs and possibly some of the Cricetine Myomorphs), which were evolved through long ages in the Northern Hemisphere and inferentially passed from North into South America by way of Mexico and Panama. The second comprises the Edentates, Primates, Marsupials, and the Hystricomorphous Rodents which, from whatever country they may originally have come, have undergone a prolonged course of evolution in South America and migrated thence into Central or even North America. That is to say, whereas North and South America have been independent geographical centres for the evolution of Mammals in the Western Hemisphere, the part played in the main by Central America has been that of a bridge joining these centres together and permitting the intermingling of the independently developed

faunas. A few genera of Chiroptera and Rodentia restricted, so far as is known, to Central America, may have been evolved within the area; but these do not alter the general character of the country as a faunistically transitional tract between the northern and southern portions of the Western Hemisphere.

That the intermingling and cross-migrations, which give the stamp to the existing Central American Mammalian fauna, began in the Miocene and have continued uninterruptedly since that date may be inferred from palæontological and geological data, which support the conclusion that the Northern and Southern Americas, separated by sea over what is now the isthmus of Panama from the earliest Eocene (Paleocene) to the end of the Oligocene, were finally joined by the elevation of that isthmus during the Miocene Period.

Possibly, as held by some authorities, Central America to the north of Costa Rica and Panama was temporarily connected with South America by way of the Greater and Lesser Antilles in the Early Oligocene; and possibly there was a still earlier union during the Cretaceous of the western portions of North, Central, and South America. However that may be, it seems tolerably certain that the main streams of migration passed by way of Costa Rica and Panama in comparatively recent Tertiary times.

Reference has more than once been made to the possibility of South America having received the ancestors of some of its characteristic forms of Mammals (Platyrhine Monkeys, Hystricomorph Rodents, Sirenians) from Africa by a direct trans-Atlantic bridge between the two continents. Other groups of animals supply evidence for the existence of this union. But if the mammals made use of it, it must have endured into early Tertiary times. This, however, has been disputed.

Another point, also under discussion, may here be referred to, although it has no direct bearing, so far as is known, upon the fauna of Central America. This is the possibility of a direct connection between South America and Australia. Perhaps the most cogent evidence for this is supplied by certain genera of invertebrates, probably in great part ancient types. So far as Mammals are concerned, the evidence rests upon the claimed relationship between the so-called Tasmanian or Marsupial Wolf (*Thylacinus*) and some extinct (Upper Miocene) Sparassodont Mammals of South America, coupled with the later date of fossil Marsupials in Australia, the absence of their remains in Tertiary deposits in China, and the absence of living forms in South-east Asia to the west of "Wallace's Line." Also there is the undeniable kinship between the Australian Dasyurids and the American Didelphyidæ, of which *Marmosa* is alleged to be the most primitive type. It would be out of place further to discuss these questions here; but the facts, as they stand, are suggestive of the origin of the Australian Marsupials from a South American stock. Moreover, if *Thylacinus* be of the same family as the Sparassodont *Prothylacinus*, it may be held as perhaps probable that the connecting land-mass permitting the migration persisted into early Tertiary times.

Faunistic Divisions of Central America.

Central America has been described above as transitional with respect to its Mammalian fauna between North and South America. This statement, however, is perhaps too general and apt to give a mistaken impression of the actual facts; for the transition cannot be described as complete. Its incompleteness, however, is not due to the existence of any physical barriers to migration, unless temperature and moisture can be described as such. But, as will appear in the sequel, the faunistic do not coincide with the political divisions of this land-area.

The central portion of Mexico forms an extensive plateau rising some 9000 feet above the sea, with mountains nearly twice that altitude. This tableland to the north is continuous with, and closely resembles in its characters, a great tract of comparatively dry territory stretching into North America and embracing the southern parts of California, Lower California, Nevada, Arizona, and nearly the whole of Texas. Southwards the plateau is continued by the mountain ranges which stretch throughout the southern States of Central America In Mexico it rises somewhat abruptly from the lower-lying country towards the coast on each side of it; and this country, covered for the most part with tropical forest, extends to east and west of the plateau up to or almost up to the confines of the United States. Tropical forest-conditions also prevail over the greater part of Central America to the south of the plateau, although, as has been stated, the country is almost everywhere broken up by mountains rising several thousand feet above sea-level.

It is needless to recapitulate here the facts set forth above regarding the distribution of the families and genera of Mammals inhabiting Central America. It is clear, however, that those believed to have undergone a long course of evolution in South America (Primates, Edentates, Hystricomorphous Rodents, and Marsupials) are wholly, or in the main, restricted to the forested tracts above described, although not by any means occurring throughout such districts. Most of the genera and families do not pass north of Vera Cruz, in Mexico, and Guatemala. Notable exceptions are the Armadillo (*Dasypus*) which reaches Texas, some of the Opossums which occur on the Mexican plateau—one, indeed, penetrating far to the north in the United States,—and the Porcupine (*Erethizon*), belonging to the same family as *Coendou* and ranging from Arizona to Alaska.

Similarly, with the groups which, although known to have been evolved in North America or Eurasia, are now dominant in the southern tropical districts of America, such as the Tapirs, Peccaries, Brockets (*Mazama*), most of the Felidæ, some Procyonidæ (*Nasua*, *Potos*), and Mustelidæ (*Tayra*, *Grison*). These genera, usually regarded as intruders from the south, though the evidence on that head seems inconclusive, are mostly restricted to forest-covered tracts of Central America. And the same thing applies to the Bats of the families Phyllostomidæ, Desmodontidæ, etc.

On the other hand, there are a great many genera like the Prongbuck (*Antilocapra*), Bison (formerly), Rocky Mountain Sheep, Beaver, Prairie-Marmot (*Cynomys*), Chipmunk (*Eutamias*), Black Bear, Wolf, Lynx, and other typically North American forms which are restricted in Central America to the Mexican plateau or to the highlands just to the south of it.

These differences in distribution exist quite apart from the occurrence throughout Central America of many families and genera like the Hares (Leporidæ), the typical Squirrels (*Sciurus* etc.), the Shrews (Soricidæ), Pocket Gophers (Geomyidæ), Raccoon (*Procyon*), Deer (*Odocoileus*), and others.

Zoogeographers have given practical expression to the facts above set forth by referring the plateau of Mexico to the same zoological region as the southern States of North America. Out of a number of titles that have been proposed for this region, Sonoran is the one preferred. The rest of Central America, on the other hand, is regarded as a subregion of the Neotropical Region—sometimes called the Neogæic Realm,—which embraces, in addition, the Antilles and the whole of South America. On the western side of the plateau this region stretches to about lat. 25° N., and on the eastern side a little farther, stopping short near the Nueces River in Texas.

The subregional distinctions between the tropical portions of Central America and the adjacent portions of South America are not sharply defined, and rest upon the not very satisfactorily established statistics of the comparatively small number of typically South American genera which occur in those areas of Central America, and the presence in the latter of certain Sonoran forms (Soricidæ, Geomyidæ) whose southward range practically stops short at Panama.

Similarly, the Antillean subregion is characterised mainly by the poverty of its fauna in types occurring in Central and South America. It is noticeable that the orders of known northern origin are practically absent. Some of the Chiroptera (*Eptesicus*, *Myotis*) are, perhaps not surprisingly, exceptional. Most of the genera of this order belong to the Tropical American family Phyllostomidæ. For the rest, the Hystricomorph Rodents are represented by *Capromys*, *Plagiodontia*, and *Loncheres*, all Octodonts, the first two being peculiar to the subregion, by *Dasyprocta*, and possibly by a species of *Coendou*. Very interesting is the occurrence of a Cricetine Myomorph, *Megalomys*, peculiar to the Lesser Antilles. Monkeys, however, are absent, and the Edentates are represented only by one species of Armadillo (*Dasypus*) from Grenada. Finally, the Insectivora are exemplified by the Cuban and Haitian *Solenodon*, whose nearest living allies are the Centetidæ of Madagascar (*Centetes* etc.) and West Africa (*Potamogale*). The family Solenodontidæ, however, dates back to the Lower Oligocene in North America, where one genus, *Micropternodus*, has been discovered.

Until the Mammalian Palæontology of the West Indies has been worked out, the geological history of these islands cannot be accurately read. Nevertheless, temporary union between the Lesser Antilles and South America is indicated by the occurrence

of such genera as *Loncheres*, *Dasyprocta*, and *Dasypus*. Furthermore, the restriction of *Capromys* to Cuba, Jamaica, and some of the islands towards Central America and the kinship between this genus and living and fossil South American genera suggest a connection between Central America and those islands of the Greater Antilles. But this conclusion cannot at present be reconciled with the absence of other Central American forms, both of northern and southern origin, from the Greater Antilles. If, on the other hand, the Hystricomorphs passed into South America from Africa or South Europe, and if the West Indies formed part of the transatlantic land, the faunistic resemblance between Haiti, Cuba, Jamaica, and South America supplied by *Capromys* and *Plagiodontia* may be due to the derivation of the fauna from a common African source. The relationship between *Solenodon* of Cuba and Haiti and the Afro-Mascarene Centetidæ has an interesting bearing on this question, although, if *Micropternodus* be, as alleged, a Selenodont Insectivore, Cuba and Haiti must presumably have been connected with some part of North America.

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REPTILIA, BATRACHIA, AND PISCES.

By C. Tate Regan, M.A.

It has been found convenient to deal with these groups in the reverse order to that indicated in the heading of the chapter, and to take the Fishes first.

PISCES.

Marine Fishes.—It is well known that the fishes of the Pacific coast of America, from California to Peru, are quite distinct from those of the tropical Indo-Pacific, and are related to those of the Antillean district. At one time it was thought that a large proportion of the species were found on both the Atlantic and Pacific coasts, but the most recent work tends to show that when pelagic fishes of wide distribution are eliminated the number of species identical on the two coasts is very small. There are, however, many closely related species that represent each other on the Atlantic and Pacific coasts, and the inference is that each pair has evolved from a parent form that existed when the two oceans were connected. There is evidence that North and South America were separated by sea during the Eocene, and became one continent in the Miocene; if this were so, the similarity and degree of dissimilarity between the tropical shore-fishes of the Atlantic and Pacific coasts would be satisfactorily explained.

Fresh-water Fishes.—Fishes that are found in lakes and rivers sometimes belong to marine species that enter fresh water for purposes of breeding or feeding; such species may form permanent fresh-water colonies or races, and these lead to fresh-water species of marine genera and fresh-water genera of marine families. These are unimportant in zoo-geography, but there are many families and even some orders that are confined to fresh water, and appear to have evolved their genera and species in fresh water; their dispersal has depended on hydrographical changes, such as the union of rivers formerly distinct or the capture by one stream of the tributaries of another, and for most of them the sea appears to be an impassable barrier. Such fishes may be termed true fresh-water fishes, and they are of the highest importance as indicating former land-connections or ancient lines of severance.

The Neotropical Region.—South America has a rich and varied fish-fauna, surpassing that of any other region for wealth and individuality. As in other parts of the world, except the Australian Region, the majority of the true fresh-water fishes belong to the order Ostariophysi *. This order comprises two well-marked suborders,

* *Cf.* Ann. & Mag. Nat. Hist. (8) viii. 1911, pp. 13–32, 553–577.

Cyprinoidea (Characins, Electric Eels, Carps, Loaches) and Siluroidea (Catfishes). Of the Cyprinoids the Cypriniformes are absent from South America; the Characiformes (Characins) are represented by five families—four endemic and the other, the most generalized, found in Africa also; whilst the Gymnotiformes (Electric Eels) are peculiar to the Neotropical Region. The Siluroids include the archaic *Diplomystes* of Chile and eight endemic families, of which the most generalized, Pimelodidæ, is related to the African and Indian Bagridæ. The only other Neotropical fishes of much importance geographically are the Cichlid Perches, also found in Africa, for the Cyprinodonts are partly marine and the sea has aided in their dispersal.

Origin of Neotropical Fishes.—It has been suggested by various authors that the ancestors of the characteristic neotropical faunal groups may have reached South America in late mesozoic or very early tertiary times either from Australia *viâ* Antarctica, from North America, or from Africa *viâ* an Atlantic continent. Recently * I have attempted to show that the evidence for the supposed connection with Australia does not warrant the conclusions that have been reached; so far as the true fresh-water fishes are concerned, there is only one family common to Australia and South America, the Osteoglossidæ, a generalized, ancient, and widely distributed group represented at the present day by a few remnants. As to North America, it has not, at the present day, a single family in common with South America, and the fossils show that it has been just as distinct throughout the tertiary. Cat-fish (*Rhineastes*), an Osteoglossid (*Dapedoglossus*), and a Perch (*Priscacara*) from the Green River Shales (Lower Eocene) in Wyoming have been cited as showing neotropical affinities †. In my opinion, *Rhineastes* may belong to the cosmopolitan and marine family Ariidæ, *Dapedoglossus* seems to be nearer to the Indo-Australian *Scleropages* than to the South American *Osteoglossum*, and *Priscacara* is not a Cichlid. All the Cichlidæ, whether African or American, have the palate toothless, and the caudal fin formed of 16 principal rays, 14 branched. *Priscacara* has teeth on the vomer and 17 principal caudal rays, 15 of them branched. After examination of the specimens in the British Museum, I conclude that *Priscacara* is a member of the endemic Nearctic family Centrarchidæ, and is closely related to the modern *Eupomotis*, in which genus the enlargement and coalescence of the lower pharyngeals may also be seen. If the ancestors of the present Neotropical fishes came from North America, no trace of them has yet been discovered.

The hypothesis of a former land-connection between South America and Africa receives strong support from the Fishes; although no genera of the Characidæ and Cichlidæ are common to the two continents, the close relationship of *Brycon* and

* Brit. Antarctic 'Terra Nova' Exped., Fish. 1914.

† Osborn, 'The Age of Mammals,' p. 136.

Alestes of the Characidæ, and of *Acara* and *Paratilapia* of the Cichlidæ, seems apparent. Further support is derived from the Lepidosirenidæ, with *Lepidosiren* in South America and *Protopterus* in Africa, and from the relationship of the Pimelodidæ and Bagridæ.

Evolution and Dispersal of Neotropical Fishes.—Since all the genera and most of the families of true fresh-water fishes of the Neotropical Region are peculiar, and the majority of the endemic families may be regarded as specialized Characidæ or Pimelodidæ, it may be inferred that the present fish-fauna has evolved in South America from a few ancestral types, and that it has received no immigrants from other regions since the earliest of the Tertiary.

It is generally accepted that the Antillean Region was submerged during the Eocene, and that the invasion of Central America from the south dates back not earlier than the Miocene. The distribution of the fishes is in harmony with this supposition, for, whilst most of the Neotropical families have a wide range in South America, only four of them extend north of the isthmus of Panama. One of these is the Gymnotidæ, represented by *Gymnotus carapo* (*Giton fasciatus*), found everywhere from Montevideo to Guatemala; the others are the Pimelodidæ, Characidæ, and Cichlidæ. The Pimelodidæ are represented mainly by about twenty species of the large and widely distributed South American genus *Rhamdia*, which ranges north on the Atlantic side to southern Vera Cruz, but has not reached the Balsas nor the Mexican Plateau.

A few genera of the Characidæ have got as far as *Rhamdia*, and it is only two or three forms that are scarcely specifically distinct from *Tetragonopterus* (*Astyanax*) *rutilus*, found everywhere in South America north of the La Plata, that extend the range of this family to the Balsas and on the Atlantic slope to the Rio Grande.

In the Characidæ and Pimelodidæ invasion of Central America has resulted in the differentiation of a number of species, but has produced no types that are markedly distinct from their relatives in South America.

The Cichlidæ are in many respects peculiar; the Central and South American species are about equal in number and for the most part are generically or at least subgenerically distinct, so that it is usually possible to recognize at a glance whether a species is Central or South American. The South American types are the more generalized, for the majority have three anal spines and simple conical teeth; in the Central American genera the number of anal spines is increased and various specializations of the dentition occur. The great lakes of Nicaragua have a highly specialized endemic Cichlid fauna; many species are found in the region between Panama and southern Vera Cruz, and a few in the Atlantic coast-streams northwards to the Rio Grande. Only one species, belonging to the genus or subgenus *Parapetenia*, is found in the Balsas and a related form in the lowland streams of Sinaloa; a species of this type also occurs in Cuba. The Central American Cichlidæ are a difficult group

for the systematist; the species are closely related and the genera ill-defined. They give the impression that their number and variety, as compared with the Characidæ and the Pimelodidæ of this area, are not due to an earlier migration, but to a greater capacity for differentiation and a more rapid evolution.

The Nearctic Region.—North America has a fish-fauna as different as possible from that of South America. The Ostariophysi are represented by the Catostomidæ (Suckers) and by a family of Cat-fishes, the Amiuridæ, each restricted to this region except for one or two species in China; in addition, there are a number of Leuciscine Cyprinidæ, a group well represented in Eurasia. The Perches belong to the endemic family Centrarchidæ and to the Percidæ. The Cyprinidæ, Percidæ, Esocidæ, and Umbridæ are holarctic, but there are several endemic families, Hiodontidæ, Percopsidæ, etc., in addition to those mentioned above, that make this region quite distinct from the Palæarctic.

Origin of Nearctic Fishes.—Numerous fresh-water fishes have been described from early Tertiary deposits in North America. Lepidosteidæ and Amiidæ were already present in the Upper Cretaceous or Basal Eocene of North America and Europe. An interesting assemblage is known from the Lower Eocene (Green River shales) of Wyoming, including Percopsidæ or Aphredoderidæ (*Amphilaga* and *Erismatopterus*), Percidæ (*Mioplosus*), and Centrarchidæ (*Priscacara*), as well as the Osteoglossid *Dapedoglossus*; there are some other fishes that may have been marine as well as fresh-water, e. g. *Xiphotrygon* (Trygonidæ), *Notogenus* (Chanidæ), *Diplomystus* (Clupeidæ), and *Rhineastes* (Ariidæ). Catostomidæ are also known from the Eocene and *Amiurus* from the Lower Miocene.

The known history of the Nearctic fishes is in harmony with the supposition that North America separated from Eurasia at the end of the Cretaceous and developed several of its endemic types during the Eocene, and that since the Eocene one or more connections with Eurasia have brought Leuciscine Cyprinidæ to America, and have established two or three Catostomids and Amiurids in China. The identity of some of the more northern species of the two continents shows that a connection across the Behring Sea must have persisted until a recent date.

Dispersal of the Nearctic Fishes.—In the Mississippi all the characteristic nearctic types are represented; to the north, west, or south there is a marked impoverishment. In the Rio Grande, Hiodontidæ, Percopsidæ, Aphredoderidæ, Umbridæ, and Esocidæ are absent, and the Percidæ and Centrarchidæ are reduced to a few species only; there are several Cyprinidæ and Catostomidæ. Isolated streams and lakes of Chihuahua and Durango, the portions of the Yaqui and Mezquital Rivers east of the Sierra Madre, and the rivers of Tamaulipas and northern Vera Cruz have a fish-fauna essentially similar to that of the Rio Grande. On the southern part of the Mexican Plateau, the Rio Grande de Santiago or Lerma above the falls, with the

isolated lakes of the states of Michoacan and Mexico, constitute an important system with a very characteristic fish-fauna formed almost entirely of endemic species. Only three families of Nearctic fishes are present; the Catostomidæ are represented by a single species of *Moxostoma* and the Amiuridæ by an *Amiurus*, whilst there are a dozen Cyprinidæ, nearly all belonging to endemic genera. The majority of the fishes belong to two groups, each with about a score of species, and each belonging to a family that includes a number of marine fishes that enter fresh water. These two groups are characteristic of the Lerma System and barely overstep its limits; one is the somewhat heterogeneous Atherinid genus *Chirostoma*, the other is the Cyprinodont subfamily Characodontinæ, which includes five well-marked genera, and differs from the Fundulinæ in that its species are viviparous.

The Lerma System has evidently long been isolated, and has been a centre of evolution. The chain of volcanoes that border the Mexican plateau to the south have barred invasion on that side, and from the north only a few nearctic types have reached the Lerma. The main elements of its fish-fauna, *Chirostoma* and the Characodontinæ, have in all probability evolved each from a single ancestral type that entered from the sea, from which it is now separated by inaccessible falls.

The Rio Balsas lies to the south of the Mexican plateau, and is a large river that flows into the Pacific; it has not been thoroughly investigated, but appears to have a comparatively poor fish-fauna. In addition to a Lerma type (*Goodea*) that has got into the headwaters of its northern tributaries, there is a Cat-fish (*Amiurus*) and a Cyprinoid (*Notropis*); two neotropical species balance these. The high mountains that bound the Balsas System have evidently rendered immigration a difficult feat.

It is in the lowlands of the Atlantic slope that conditions have been more favourable to migration. *Lepidosteus*, absent from the Mexican plateau and from the Balsas, has reached Panama, and a species of *Ictiobus* (Catostomidæ) and an *Amiurus* occur in the Usumacinta, balancing the Cichlid and Characid species of the Rio Grande.

Dispersal of Neotropical and Nearctic Fishes compared.—It has been shown above that comparatively few elements of the rich neotropical fish-fauna extend north of the Isthmus of Panama, and that of these only the Cichlidæ exhibit much diversity and specialization. In Central America and in rivers of the Atlantic slope of Mexico south of Vera Cruz the fish-fauna is almost exclusively neotropical, but only two neotropical types have reached the Balsas, none have surmounted the volcanic chain that borders the Mexican plateau, and only half a dozen have penetrated north of Vera Cruz in the Atlantic coast-streams of northern Mexico. In these streams there are many nearctic species, but in Atlantic rivers south of Vera Cruz only three. The Rio Grande exhibits a paucity of nearctic types as compared with the Mississippi, and this is still more marked in the Lerma System, which possesses a peculiar endemic fish-fauna. In the Balsas, equally isolated from the north and the south, nearctic and neotropical species balance, but there are only two or three of each.

It is probable that the distinctness of the North and South American faunas is more marked, and that where they meet there is less overlapping in the case of the fresh-water fishes than in any other group of animals.

Fresh-water Fishes.—General Conclusions.—The South American fresh-water fish-fauna is as distinct as the Mammalian fauna would have been if a large part of the endemic fauna had not died out in late Tertiary times, and been replaced by the invasion of types that had evolved elsewhere.

Turning to the other parts of the world, we find that the distinctness of the Australian Region, marked in the Mammalia, is emphasized by the Fishes. The effectiveness of the sea as a barrier is strikingly illustrated by a comparison between Borneo, with its hundreds of species of Cyprinoids, Siluroids, Anabantoids, etc., and Celebes, without a single indigenous true fresh-water fish. The other four regions are well characterized, although less distinct, for the Indian has certain relationships with the Ethiopian and Palæarctic, and the last with the Nearctic; there has been a certain interchange, but in each case the endemic groups preponderate.

The general impression derived from a study of the fresh-water fishes of the world is that many of the families were in existence at the beginning of the Tertiary, that for the most part they have evolved in the areas they now occupy, have dispersed slowly, and have never had a distribution much wider than at present. For Mammals, it may be generally stated that they have evolved rapidly and spread rapidly, and have found it easier to reach a country than to live in it. For fresh-water fishes migration has been much more difficult, survival relatively easy; hence their great importance in zoogeography.

BATRACHIA.

Batrachians.—These resemble fresh-water fishes in their inability to swim across the sea, and their eggs are no more likely to be transported over the sea than those of fresh-water fishes. But it is probable that accidental transmission has played a part in the dispersal of some arboreal and terrestrial frogs; at any rate, this seems the most reasonable explanation of the distribution of certain genera and species in the Indo-Australian Archipelago. Even the most aquatic types can travel overland from one stream to another, and consequently are able to migrate rapidly when conditions are favourable.

Nearctic and Neotropical Batrachians.—The Batrachian faunæ of these two regions are less distinct than the fish-faunæ, but are, nevertheless, very different. Urodeles are scarce in South America, Cœcilians are absent from North America; the majority of the Neotropical Frogs are Cystignathidæ and Hylidæ, families but sparingly represented in the Nearctic Region.

The mountains that fringe the Mexican Plateau form the boundary between the

the Nearctic and Neotropical regions; only a small proportion of the tropical genera have gained a footing on the plateau, and but a few undoubted northerners have spread far to the south beyond it.

The Urodela are almost exclusively holarctic and aquatic; except the monotypic *Thorius*, known only from the mountains of Orizaba and Oaxaca, but two genera, *Amblystoma* and *Spelerpes*, extend southwards into Mexico and Central America. Each of these genera has several species in the United States, and whilst *Amblystoma* has one in the mountains of Siam, *Spelerpes* includes one from Sardinia and Italy. These isolated species suggest that both genera had formerly a wider and a more northerly range, and that only one Old World species of each managed to survive the glacial epoch by migrating southwards. In America *Amblystoma* extends on to the Mexican plateau and the mountains that fringe it, but *Spelerpes* includes about seven species from the United States, fifteen from the mountains of southern Mexico and Central America, three from the Andes of Peru and Colombia, and one from Haiti. It seems evident that this genus began to spread southward as soon as the elevation of Central America enabled it to find a congenial temperature at high altitudes.

The Cœcilians are vermiform, apodal, burrowing animals that inhabit the Neotropical, Ethiopian, and Indian regions. There are a few Central American species, and one of these, *Dermophis mexicanus*, ranges north to southern Vera Cruz. Nothing is known as to the past history of this group, and they may or may not be ancient inhabitants of South America.

The Anura, or Frogs and Toads, may be aquatic, terrestrial, arboreal, or fossorial. Some genera and species have an extremely wide range, and, although it is evident that the sea forms an impassable barrier for the majority, it seems probable that accidental transmission has played a part in the dispersal of genera such as *Rana* and *Hyla*.

The two main divisions of the Anura—Firmisternia and Arcifera—may or may not be natural, but the further classification into families is unsatisfactory; the Cystignathidæ, for example, are heterogeneous, as the Australian genera are very distinct from those inhabiting South America, the latter appearing to form a natural group. The Bufonidæ also may be an artificial assemblage.

To the Firmisternia belong the Ranidæ and Engystomatidæ, abundant in South America, Africa, India, and ranging eastwards to New Guinea and beyond. There are several endemic South American genera, and two or three with Central American species also. *Engystoma* extends from Paraguay to Texas and Florida. *Hypopachus* has one species ranging from Brazil to Costa Rica, another from Ecuador to Guatemala, and a third from Western Mexico to Texas. The only other genus of the group found in North America is the nearly cosmopolitan *Rana*, which extends

southward to the Andean region of South America, and is doubtless a recent immigrant. Gadow suggests that on reaching South America it gave rise to the endemic neotropical genera referred to the Ranidæ, but it is possible that these are derived from an ancient neotropical stock, for at least one recent genus of the Ranidæ dates back to the Eocene, and the family itself may have a greater antiquity.

Of the Arcifera, the American Cystignathidæ are almost exclusively neotropical; there are several endemic South American genera, and of those that range northwards into Central America only *Syrrhophus*, *Hylodes*, *Leptodactylus*, and *Borborocœtes* are represented on the Mexican plateau by a few species; none range further north.

The Hylidæ are mainly neotropical and arboreal, and except for one or two species of *Hyla* are absent from the Mexican plateau. Only *Hyla* ranges outside this region through North America to temperate Eurasia and southwards through China to Burma, then comes a gap, for the Australian Region is rich in species, only one of which crosses Wallace's Line into the Sunda Islands. The presence of *Hyla arborea* in Madeira and the Canaries, the range of *H. dolichopsis* from Sumatra to the Solomons, suggest that these tree-frogs may be carried across the sea, and that their wide distribution may be partly due to this; their absence from Africa and India is remarkable, but there are other equally curious cases of discontinuous distribution in genera of no great antiquity, and it is unnecessary to infer some special connection between Australia and South America to explain this one; nor does the distribution of the Cystignathidæ support this view, for the Australian members of the family are by no means closely related to the American ones, and their common ancestor must date back well into mesozoic times.

Of the American genera referred to the Bufonidæ two are strictly neotropical, *Engystomops* ranging from South America to Tehuantepec, and the monotypic *Rhinophryne* occurring on the Atlantic slope from Vera Cruz to Guatemala. The third genus, *Bufo*, is cosmopolitan except for the Australian Region; there are a number of species in Central America and southern Mexico, whilst others on the Mexican Plateau range into the southern United States. Except for two species in Celebes, *Bufo* is absent from the Australian Region, although there are many species in the Malay Peninsula and Archipelago; this is exactly the reverse of what occurs in *Hyla*, and *Rana* differs from both, as it is well represented in both Indo-Malayasia and Austro-Malayasia eastwards to the Caroline Islands.

Scaphiopus, the American representative of the family Pelobatidæ, is related to the European *Pelobates*; there are about eight species from the United States and the Mexican Plateau; these are diggers in the sand, and do not range southwards beyond the mountains of Southern Mexico.

Dispersal of Batrachians.—The Anura and Urodela are both known to date back to the Jurassic, and this, as well as the presence in New Zealand of a Toad

(*Liopelma*), indicates that in all probability some of the Batrachian families are more ancient than those of fresh-water fishes. There seems no reason to doubt that they can and have spread rapidly, but probably their main distribution was accomplished before the Tertiary. The Urodela have in all probability always been northerners, and have only recently penetrated into South America. The Cœcilians are tropical, but their absence from the Australian Region rather tells against the idea that they are a very ancient group. Many families of the Anura are widely distributed and probably ancient; the Cystignathidæ and Hylidæ seem to be old neotropical families.

REPTILIA.

Reptiles.—Leaving out the aquatic members of this group, some Reptiles can and do swim across the sea; others that are arboreal or that burrow into or hide in trunks of trees are peculiarly liable to accidental transmission over the ocean. Nearly all can travel quickly overland, so that in all probability the dispersal of many groups has been accomplished rapidly. The difference between the Nearctic and Neotropical regions is decidedly less marked than in the Batrachians, but the boundary is the same.

Of the groups of Reptiles represented in Central America the Crocodiles and Tortoises are ancient and seem to have been cosmopolitan at the beginning of the Tertiary; a study of their present distribution leads to no very important results. The Lizards and Snakes are the dominant orders of the present day, but their past history is almost unknown; in all probability the principal families date back to early Eocene times, and as they developed during the Tertiary they may have used the same routes of migration as the Mammalia.

Dr. Gadow's papers on the Reptiles and Batrachians of Mexico and Central America have been referred to above (p. 59) and are of great interest, especially when they deal with the effects of altitude, climate, terrain, etc., on the distribution; his deductions as to the origin and migrations of the different groups are necessarily based mainly on their present distribution, and are to that extent unsatisfactory. The Mammals, whose evolution during the Tertiary, extended migrations, survivals, and extinctions are very thoroughly known for several orders, teach that it is very unsafe to deduce centres of origin and dispersal from present distribution alone.

Lizards.—There appear to be no families of Lizards restricted to South America, but most of the 35 genera of one family, the Teiidæ, are peculiar to that continent; half a dozen South American genera range into Central America, two reaching southern Mexico, and one—*Cnemidophorus*—the United States. This genus includes species on the Mexican plateau, as well as in the lowland forests. The conclusion that this is an old neotropical family seems not unreasonable, but may be incorrect; the neotropical Monkeys furnish a parallel.

The family Amphisbænidæ comprises burrowing Lizards, with limbs reduced or absent; the majority of the genera are neotropical or African, but the most generalized genus, and the only one with fore limbs, *Chirotes*, is found in California and Mexico, and the least specialized of the rest, *Blanus*, inhabits the countries round the Mediterranean. Moreover, *Rhineura* of Florida is known to date back to the Oligocene of Dakota. Here an American distribution similar to that of the Teiidæ is coupled with indications that the group may have been originally a northern one that migrated southwards into Africa and South America.

The Scincidæ, widely distributed in the Old World, have in all probability reached America quite recently, as the three genera found in America are also Asiatic. *Eumeces* has several North American species, and extends southward over the plateau to southern Mexico. *Lygosoma laterale* of the southern United States ranges southward to southern Mexico, and in Guatemala is replaced by the closely related *L. assatum*. *L. laterale* is almost identical with *L. reevesi* of China and Burma, and it may be that in the warmer climate of Pliocene times the ancestral type ranged northward to the land connecting Asia with America. The third American genus, *Mabuia*, is found also in Africa and southern Asia; there is an Antillean species, one from Costa Rica, and four from South America, one of these extending northward to Yucatan and southern Vera Cruz. This neotropical distribution of a genus that in all probability came through North America parallels that of *Tapirus*.

The Iguanidæ are American, except for two genera in Madagascar and one in the Friendly and Fiji Islands. They are also known from the Eocene of Europe, and are evidently an ancient group of former wide distribution; the presence of two peculiar genera in the Galapagos suggests their antiquity in South America. The South American genera are numerous; the majority are restricted to South America, but some are also Antillean, and some extend through Central America as far as southern Vera Cruz; there are also two or three genera peculiar to Central America. There are about ten genera in the south-western United States, some with species on the Mexican Plateau and the western Sierra Madre. One species of *Uta* (*U. bicarinata*) is found on the plateau and also on the west coast from Presidio to Tehuantepec. *Sceloporus* and *Phrynosoma* are important genera that range from the southern United States to Central America, and include species on the plateau as well as in the lowlands.

The Geckonidæ are found in all tropical countries; in America they are almost entirely neotropical, and are not found on the Mexican plateau. The Geckonidæ are peculiarly liable to accidental dispersal, and this is well illustrated by the distribution of *Gehyra mutilata*; it is found on the islands of the Indian Ocean and the Malay Peninsula and Archipelago eastward to New Guinea, but it is also known from Western Mexico. The small family Eublepharidæ, specialized Geckos, includes three species from Africa and India, distinguished by their stout form and by their enlarged

chin-shields from the four American species; two of these, from Texas and California and from the West Coast of Mexico, differ in their scaling from the other more tropical species, one of which inhabits Panama and the other ranges from Costa Rica to Vera Cruz.

The other families of Lizards found in America teach us nothing more than those dealt with above. There are several families common to the nearctic and neotropical regions, and most of these are found in other parts of the world also. South America is much richer in genera and species than North America; most of the Lizards of Central America north to the outer slopes of mountains that border the Mexican plateau belong to or are related to South American genera, and most of those found on the plateau are generically distinct from them, but in some cases (e.g. *Sceloporus*, *Phrynosoma*) only specifically so.

There is not, on the whole, a very fundamental difference between the Lizard faunæ of North and South America; considering the differences in climate, and other features, we should expect most of the genera to be distinct, and in southern Mexico the transition from an elevated, dry, and almost treeless plateau bordered by mountains to a lowland district with tropical rainfall and vegetation accentuates this distinctness. But there are few differences that can be assigned definitely to the former isolation of the two continents, as practically nothing is known of the Tertiary history of the group. We know that some Mammalian genera, now tropical, formerly ranged further north and migrated from Asia to North America and thence to South America in late Tertiary times. Doubtless some Lizards, such as *Mabuia*, had a similar history; but whether the Teiidæ, for example, were formerly nearctic, or whether they are for the first time spreading northwards, is a question difficult to answer.

Snakes.—The burrowing snakes of the genus *Typhlops* have a wide distribution in the tropics; there are a few species in Mexico and Central America, and one of these is *T. brahminus*, collected by Dr. Gadow in Michoacan. Previously this species was known to range from Africa to China and on islands eastward to the Moluccas; probably it will be found on some of the islands of the Pacific. This is an interesting parallel to the Gecko *Gehyra mutilata*; in both cases Indian species have reached the West Coast of Mexico, and appear to have established themselves. The occurrence of *Typhlops* on oceanic islands indicates that the wide range of this genus is not due to its antiquity, but to susceptibility to accidental dispersal.

Another genus of burrowing snakes, *Glauconia*, is found in America, Africa, and south-western Asia. *G. albifrons* is tropical, ranging from Argentina to southern Mexico, but other species are found on the Mexican plateau and in the southern United States.

The Boidæ show some points of interest. The Pythoninæ include a score of species from Africa, India, and Australia and a single American species, *Loxocenus bicolor*,

from Guatemala and southern Mexico. The Boinæ are widely distributed in the Old World, but the majority are American, and the occurrence in Madagascar of species of the Tropical American genera *Corallus* and *Boa* is curious; it is evident that these genera had formerly a much wider range.

Many other genera of snakes have a wide distribution; thus the Crotalidæ have several genera common to Asia and America, and, although they extend southwards to the La Plata, there are no peculiar Neotropical genera. One species of *Crotalus* ranges from the United States to Argentina.

Without going into further details, it may be said that, as compared with the Lizards, a larger proportion of the Central American genera are found also on the Mexican plateau and in the southern United States, although there are, of course, a number of neotropical genera that range northwards only to southern Mexico.

The Amblycephalidæ are the only family of snakes that are strictly neotropical in America; there are three South American genera, one of these, *Leptognathus*, having several Central American species, the northernmost in Tehuantepec. The other two genera occur in South-Eastern Asia, and it is probable that the family was formerly a northern one. Indeed, it is not unlikely that the whole neotropical Ophidian fauna has been derived from immigrants from the north that did not begin to reach South America until the Miocene connection was established. The distribution of the vast family Colubridæ seems to favour this view.

REPTILIA, BATRACHIA, AND PISCES.

Summary.—The mountains that fringe the Mexican Plateau form the boundary between the Neotropical and Nearctic Regions. True fresh-water fishes can neither cross seas nor travel overland from one river to another; consequently their dispersal has been slow. The nearctic and neotropical fishes are quite different, and belong to different families; the two faunæ scarcely overlap; in the Lerma System, on the southern part of the Mexican plateau, there are no neotropical fishes, the nearctic fishes are mostly generically distinct from those of the Rio Grande, and two endemic groups that are neither nearctic nor neotropical are the most important elements.

For most Batrachians the sea is an impassable barrier, but they can migrate overland and their dispersal may have been rapid. The nearctic and neotropical Batrachians are mostly distinct, but overlap to a considerable extent; a few genera (*Bufo*, *Hyla*) range throughout both regions. The rapidity of dispersal as compared with the fishes is exemplified by the holarctic group Urodela; one genus, *Spelerpes*, has penetrated far into South America, whereas only one nearctic fish, the ancient *Lepidosteus*, has reached Panama. The spreading of *Amblystoma tigrinum* of the United States southwards to the border of the Mexican plateau is in striking contrast to the peculiarity of the fish-fauna of the southern half of the plateau, where no species

of fish occurs that is found in the United States. Crocodiles and Tortoises, like many families of Anura, are ancient and widely distributed. Snakes and Lizards are more modern, and their dispersal seems to have been recent and rapid; in these groups there is no marked difference between the nearctic and neotropical regions; no orders or families that show much regard for the boundary; the differences are for the most part generic or specific, and are mainly due to the sudden change from the dry plateau of the southern United States and Mexico to the tropical forests of Central America.

Of the groups dealt with in this chapter, only the Fishes give clear indications as to the past, and from them we infer a Cretaceous connection between South America and Africa that may have persisted into the Eocene, and was succeeded by a long isolation of South America and in the Miocene by its connection with North America, which has been since the Eocene until quite recently more or less continuously connected with Asia across the Bering Sea.

ARACHNIDA *.

By R. I. Pocock, F.R.S.

Introduction.

Discussions on the geographical distribution of the Arachnida, especially of Scorpions, commonly open with a reference to the great antiquity of the group, and to the possibilities thus afforded it of achieving cosmopolitan dispersal. Dr. Hans Gadow, for instance †, dismisses the Scorpions in the following paragraph:—"This group is a good illustration of the effect of great antiquity. Scorpions already existed in the Silurian, and even some existing species date back to the Coal Measures! They have had every chance of spreading widely. A species of *Tityus* is preserved in Miocene amber of the Baltic, this genus is now restricted to southern South America. The group is cosmopolitan, limited only by cold, yet it is absent from New Zealand. They show scarcely any generic affinity between the Old World and the New, nor between South America and Australia. They have had sufficient time to develop along lines aloof from each other in these great land complexes."

Much of this is untrue both in substance and in fact. None of the many Carboniferous genera can be referred with certainty even to existing families; and the record of a species of "*Tityus*" from the European Miocene can only be regarded as evidence of the existence of the Buthidæ in the Baltic area in mid-Tertiary times; and, as regards the distribution of existing forms, if the views above expressed be accepted, there is nothing more to be said upon the subject. They are, however, inadmissible since they leave wholly unexplained the fact, singular though it be, that the present distribution of Scorpions does not attest the great antiquity of this order. If they were not known to be of Carboniferous age they might be judged, from the analogy supplied by Mammals, to date from late Mesozoic and early Tertiary times, for, as I have elsewhere pointed out ‡, if the surface of the world be regionally divided in accordance with the distribution of Scorpions, the resulting map will agree tolerably closely with the map based upon the distribution of Mammals, due allowance being made for the absence of Scorpions at the present time from all countries to the north, roughly speaking, of the 45th parallel of north latitude.

* The Opiliones and the Acari have been omitted from this essay, the former because Mr. F. O. P. Cambridge was not sufficiently acquainted with them to make his results altogether reliable, and the latter because of the imperfection of our knowledge of the Acarine fauna of other parts of the world.

† 'The Wanderings of Animals,' 1913.

‡ 'Natural Science,' iv. pp. 353–364, 1894, and 1899, pp. 213–231.

A striking Mammalian feature in the distribution of Scorpions is their absence from New Zealand. Another is to be found in the character of the Australian forms, some of which are quite peculiar, while others show affinity with genera and species from southern Asia, like the Australian Rodent Mammals, and one, like *Thylacinus*, belongs to a South American family. Again, some of the South Asiatic genera do not pass Wallace's Line, and the small number of Mascarene forms are related to, but distinct from, those of tropical Africa and Asia, like the Mascarene Civets and Lemurs. Similarly, the tropical African and Asiatic species, although related, belong mostly to distinct genera.

What is true of the Scorpions is true also, broadly speaking, of the two suborders of Pedipalpi, the Urotricha and the Amblypygi, which, like the Scorpions, existed in Carboniferous times in Europe and North America. The absence of both from New Zealand and Australia, and of the Urotricha from Africa also, are suggestive rather of comparatively recent origin than of high antiquity.

The same cannot, however, be said of a great many of the Araneæ (Spiders). The most ancient existing type, *Liphistius*, apparently related beyond doubt to Carboniferous genera, is restricted to Indo-Malaysia, whereas many genera, like *Lycosa*, *Aranea*, *Tetragnatha*, and others, not known to be ancient forms, are practically cosmopolitan in distribution. Moreover, some groups of spiders—perhaps Mesozoic or even Cænozoic, but not, so far as records tell us, Palæozoic—attest by their restriction to the southern Continents the former existence of "Antarctica" much more forcibly than the orders of Arachnida known to have been in existence in the Carboniferous Period. Another instance of the restricted distribution of a Carboniferous order is supplied by the Rianulei, which are found now only in tropical West Africa and Brazil.

Thus some of the Carboniferous Arachnida, the Scorpions, exist in Europe, Asia, Africa, America, and Australia; others, the Amblypygi, in Asia, Africa, and America; others, the Urotricha, in Asia and America; others, the Rianulei, in Africa and South America; the Mesothelid Spiders (*Liphisticus*) only occur in the East Indies, while other spiders, assumed on morphological grounds to be of later date, may be cosmopolitan, and such spiders, when young, are known by their method of floating on webs to be able to cross arms of the sea in the direction of prevalent winds *.

From these facts it seems clear that the present distribution of the Arachnida depends, not upon the duration of their existence, but upon their means of dispersal and power of adaptation to varied conditions. Hence the attempt to explain away the facts of their distribution by an appeal to their antiquity is barren of results, and, since the palæontological history of the Arachnida throws no useful light upon the matter in hand, it has been ignored in the following discussion.

* This means of dispersal is analogous to the flight of birds, whose powers to cross tracts of ocean cannot be ignored in discussions of geographical distribution.

Order SCORPIONES *.

The genera of this order recorded from Central America may be classified, with their distribution, as follows:—

Family Scorpionidæ.
  Subfamily Ischnurinæ.
    Genus *Opisthacanthus*. Panama, Colombia, W. Indies.
  Subfamily Diplocentrinæ.
    Genus *Diplocentrus*. Texas, Mexico, W. Indies, Brazil.

Family Væjovidæ.
  Subfamily Væjovinæ.
    Genus *Hadrurus*. S. States of N. America; Mexico, ? Guatemala.
    Genus *Væjovis*. S. States of N. America; Mexico.
    (Genus *Uroctonus*. California; ? Guatemala.)
    (Genus *Anuroctonus*. California, Utah, etc.; ? Guatemala.)
  Subfamily Megacorminæ.
    Genus *Megacormus*. Mexico.
    Genus *Plesiochactas*. Mexico.
  Subfamily Chactinæ.
    Genus *Broteochactas*. Panama, Guiana.

Family Buthidæ.
  Genus *Centruroides*. S. States of N. America, Central America, Antilles, S. America.
  (Genus *Rhopalurus*. Cuba, Haiti, Brazil, ? Mexico.)
  Genus *Tityus*. Mexico, Costa Rica, Panama, W. Indies, S. America.
  (Genus *Isometrus*. Commercially imported, if present.)

With the substitution of the older name Væjovidæ for Iuridæ and the introduction of the Megacorminæ, containing genera unknown to me at the time, this is the classification proposed by myself in 1893 (Ann. Mag. Nat. Hist. (6) xii. pp. 305–311) and adopted in my paper on "The Geographical Distribution of Scorpions" in 1894 (Nat. Science, v. pp. 353–364). In his contribution to the same subject published in 1905 (Zool. Jahrb. Syst. xxii. pp. 321–364), Kraepelin suggested certain modifications, erecting the Diplocentrinæ, Væjovinæ, and Chactinæ to full family rank, including the Megacorminæ as a subfamily of the Chactidæ, and making *Centruroides*, with *Rhopalurus*, and *Tityus*, the types of separate subfamilies of the Buthidæ. These amplifications, whether desirable or not, are of no importance in the present connection.

Some of the genera above enumerated have been placed in brackets because

* Although it is customary to designate the primary divisions of the Arachnida as "Orders," it must be remembered that the morphological differences between the groups of that rank are greater than those which distinguish the "Classes" of the Vertebrata.

the evidence for their occurrence in Central America is doubtful and requires confirmation *.

Distribution of the Families and Subfamilies of Central American Scorpions.

No genera of Scorpions are common to the Old and New Worlds, except *Isometrus*, one species of which has been commercially carried everywhere from the East Indies. None of the families mentioned above, however, are peculiar to America. The Old World appears to be the headquarters of the Scorpionidæ, since this family is represented there by many genera distributed over Africa, South Asia, and Australia and referable to four subfamilies, only two of which, the Ischnurinæ and Diplocentrinæ, occur also in America.

The Væjovidæ, absent from Africa and Australia, range from the Mediterranean area eastwards through North India into Further India, and reappear in North, Central, and South America, but are absent from the Antilles. Unless the Mediterranean genus *Iurus* and the Indian genus *Scorpiops* be included, as has been done, in the Væjovinæ, the American subfamilies are peculiar to the New World. But, in any case, the distinctions between the subfamilies of this family are finely drawn. Excluding the two Old World genera above mentioned, the Væjovinæ contain the four American forms enumerated above and two from South America. No other genera of the Megacorminæ are known. The Chactinæ, however, are represented by several genera in the northern countries of South America.

The Buthidæ are mainly an Old World group. The family contains a large number of genera and species in Europe, Africa, Madagascar, South Asia, and Australia. Apart from the aberrant South American genus *Ananteris*, the only known American genera are the three indigenous forms enumerated above. These do not differ more from each other, or from some of the Old World genera, than the latter differ from each other. There is no evidence, indeed, that *Tityus* is not closely allied to the Oriental genus *Isometrus*.

* The genera *Uroctonus* and *Anuroctonus*, for example, were included in my report on the testimony of Thorell, who recorded *Uroctonus mordax* and *Anuroctonus phœodactylus*, two species originally described from California, from Guatemala. The specimens he had for examination, however, were sent to him with an example of *Hadrurus hirsutus*, also a Californian species, by Dr. Gustav Eisen, who was then living at San Francisco, and my opinion that they were wrongly localised is based upon the improbability of identical species inhabiting the two countries in question. The Buthid genus *Rhopalurus* was included on the evidence of old specimens of *Rhopalurus junceus*, ticketed "Mexico" in the British Museum, the species in question having its home in Haiti. Finally, although *Isometrus* no doubt exists in the seaport towns of Central America, it has not yet been actually recorded, and as a commercially introduced form is wholly without interest.

General Features of the Scorpion Fauna of Central America.

The nine genera of Scorpions certainly ascertained to be Central American are faunistically assignable to a northern category, a southern category, and a category which is both northern and southern.

To the southern category belong *Opisthacanthus*, occurring in Panama and Colombia; *Broteochactas*, also found in Panama and the northern countries of South America (Guiana, etc.); and *Tityus*, which ranges all over South America from the Argentine northwards and is found in Panama, Costa Rica, and Mexico. The Mexican species, however, is very little known. It is not closely allied to the species from Costa Rica and Panama, which are identical with, or very nearly related to, species from the Amazons, Demerara, etc. Similarly, the species of *Opisthacanthus* and *Broteochactas* occurring in Panama are the same as species found in South America.

To the northern category belong *Hadrurus* and *Vœjovis*, which extend from the Southern States of North America into Mexico, *Vœjovis* being one of the dominant Scorpions in the latter country. It is interesting to note the wide geographical severance between these two and their nearest allies, *Caraboctonus* and *Hadruroides*, which inhabit Ecuador, Bolivia, and Chile. Also to this northern category must be referred the two genera of Megacorminæ, *Megacormus* and *Plesiochactas*, which are found in Mexico (Vera Cruz, Cordova), the latter extending to Guatemala. Their nearest allies are the Chactinæ of tropical South America.

To the category which is both northern and southern in distribution belong the genera *Diplocentrus* and *Centruroides*. The former ranges from Texas into Mexico, but not, so far as is known, to the south of the latter country in Central America. Nevertheless, it is found in the Greater and Lesser Antilles and in the northern part of South America (Brazil). *Centruroides*, on the other hand, occurs in the southern states of North America, throughout Central America, in South America as far down as Chile along the western side, in Brazil, and in the Greater and Lesser Antilles.

Thus of the Central American genera only four occur in the Antilles, *Tityus*, *Centruroides*, *Diplocentrus*, and *Opisthacanthus*.

Two of the above-mentioned genera, *Opisthacanthus* and *Diplocentrus*, are of outstanding interest from the geographical point of view, because of the singular distribution of the subfamilies to which they belong.

Opisthacanthus is unmistakably related to the tropical and South African genus *Opisthocentrus*. The generic distinction between the two is not, indeed, always admitted. Tropical Africa is also the home of several more genera of the subfamily Ischnurinæ, while others occur in Madagascar and South Asia as far east as Australasia. The kinship between the African and the solitary monotypical tropical American genus suggests that South America received this element of its fauna by means of a direct land-connection with Africa.

The distribution of the Diplocentrinæ is still more remarkable. Four genera belong to this subfamily, two being American and two Arabian. In addition to *Diplocentrus* *, the range of which has already been stated, America contains the well-marked genus *Oiclus*, known hitherto only from Antigua in the Lesser Antilles. The Arabian genera are *Nebo* recorded from Syria and Arabia and *Heteronebo* discovered in the island of Abd-el-Kuri by Sokotra. This singular discontinuity in distribution is closely paralleled by that of the Centipede *Scolopendra* (see p. 134). To explain it one may tentatively suggest a transatlantic connection between the Mediterranean area of Europe and America by way of the Antilles, an hypothesis supported by the survival of *Scolopendra* in the Canary Islands. Assuming this to be the explanation, it is probable that America received its Diplocentrine Scorpions from the Mediterranean area, and not *vice versâ*, because the Old World, and not the New World, is at the present time the home of the Scorpionidæ, to which the Diplocentrinæ belong.

Very little can be said about the origin of the remaining Central American genera. The absence of the Væjovidæ from tropical Africa eliminates the latter country as a possible source for this family. Its mainly extratropical range in the Old World, coupled with its existence at the present time in North America, suggests its former wide distribution in the Northern Hemisphere; and possibly the break in the distribution of the Væjovinæ in America, above alluded to, points to the southward migration of the family from the western parts of North America to the western parts of South America before the elevation of the isthmus of Panama. In this connection the absence of the family from the Antilles is significant.

The dominance of the Buthidæ in the Old World as compared with the New World suggests the Old World as the original home of the family; but whether the ancestors of the American genera entered America by a transatlantic bridge from Africa or Europe or by the known eastern or western northern routes under tropical or warm temperate conditions, it is impossible to say.

Regional and Subregional Distribution of American Scorpions.

Making allowances for incomplete knowledge, which renders accurate mapping of boundaries impossible, it seems that America may be divided by its Scorpions into the same geographical areas as those indicated by the Mammalia. The northern parts of the continent to the north, roughly speaking, of the 40th parallel agree with the corresponding areas of the Old World in being without Scorpions. This negative feature defines the Holarctic Region. Sharply distinguished from this by the presence of Scorpions are the Southern States of the Union; and the extension of two of the genera (*Hadrurus*, *Vœjovis*) into Mexico, but no farther, affiliates the greater part

* Including *Didymocentrus*, Kraepelin.

of that country with the southern United States to constitute the Sonoran Region, which corresponds with the Mediterranean Region of the Old World. Two more genera, *Uroctonus* and *Anuroctonus*, are peculiar to the Sonoran, but have not been recorded from Mexico. Probably also *Plesiochactas* and *Megacormus* from Mexico and Guatemala belong to it. The other Sonoran genera, *Diplocentrus* and *Centruroides*, extend far to the south, and link the Sonoran Region with the Antilles and not South America.

South America, the Neotropical Region, is characterised by the family Bothriuridæ, ranging from Peru, Chile, and Brazil to Patagonia; by a large number of genera and species belonging to the Chactinæ, mainly restricted to the northern parts of the continent, one genus *Broteochactas* spreading into Panama; by the Ananterinæ, a peculiar subfamily of Buthidæ; by the Buthoid genus *Tityus*, which spreads through Panama and Costa Rica to Mexico; by the peculiar genus of Ischnurinæ, *Opisthacanthus*, which occurs in Colombia and Panama; and by two peculiar genera of Væjovinæ, *Caraboctonus* and *Hadruroides*, ranging from Chile to Ecuador. Thus the southern portion of Central America contains Scorpions generically, in some cases specifically, identical with those of the northern countries of South America. If it be separated as a subregion from South America, an immaterial point, it may be defined by the absence of a large number of South American genera.

The affinities of the Antilles are certainly with Neotropical rather than with the Sonoran Region. Two Sonoran genera, *Diplocentrus* and *Centruroides*, it is true, occur both in the Greater and Lesser Antilles, but both are found in South America as well. The genus *Rhopalurus*, allied to *Centruroides*, and occurring in Haiti and Cuba, is also found in Venezuela, Brazil, and Colombia; *Opisthacanthus*, inhabiting Colombia and Panama, has been recorded from Haiti; and the essentially Neotropical genus *Tityus* exists both in the Greater and Lesser Antilles. One genus, namely *Oiclus*, is peculiar to the Lesser Antilles *. Judged from their Scorpion fauna, therefore, the Antilles may be regarded as a subregion of the Neotropical Region, characterised mainly by the absence of some conspicuous South American types, *e. g.* the Chactinæ and the Bothriuridæ.

Evidence supplied by the Scorpions for a Land-connection between South America and Australia.

Although the following fact has no direct connection with the Scorpion fauna of Central America, it is sufficiently interesting to call for mention, since it strongly

* In my paper on the Scorpions of the West Indies (Journ. Linn. Soc., Zool. xxiv. pp. 374–404, 1893), the genera *Hadrurus* and *Brachistosternus* were recorded from these islands. The specimens of *Hadrurus* and *Brachistosternus* were certainly wrongly labelled. The former, in the Berlin Museum, is, as Kraepelin has shown, an *Hadruroides* from Ecuador; and the specimen of *Brachistosternus*, one of the Bothriuridæ, is identical with a well-known Peruvian species.

confirms evidence supplied by other groups for a direct land-connection by way of the Antarctic or the South Pacific between South America and Australia.

The family of the Bothriuridæ is represented in South America by many genera and species, occurring mainly in Patagonia, Chili, the Argentine, Buenos Ayres, and Brazil. Beyond the limits of South America the family is unknown, save for the occurrence of the single genus and species, *Cercophonius squama*, which is found all over Australia, apart from its northern portions, and in Tasmania. Since South America is obviously the headquarters of the family, it may be inferred that this element of the fauna of Australia was received directly from South America; but since this Scorpion, like all Scorpions, is absent from New Zealand, it may be further inferred that New Zealand formed no part of the land connecting Australia and South America at the time the ancestor of the Scorpion in question migrated from South America.

The Scorpions thus supply evidence for a transatlantic connection between tropical Africa and South America and for a transpacific connection between South America and Australia: by means of the former America may have received certain elements of its Scorpion fauna, by means of the latter it may have contributed something to the fauna of Australia.

Order PEDIPALPI.

The existing Pedipalpi of the suborder Urotricha are referred to a single family, the Thelyphonidæ, which extends in the Old World, where it is represented by many genera, from India to Austro-Malaysia and northwards to China and the Philippine Islands; and in America from the Southern States of the Union to Brazil. Two genera only are known from America, *Thelyphonellus* from the Amazons and *Mastigoproctus*. The latter is represented by a few species in Brazil, a few in the Lesser and Greater Antilles and two in Central America, one recorded from Guatemala, the other from Mexico (Cordova, Jalisco, Guerrero, etc.). The Mexican species extends into Texas and adjoining States of North America.

The nearest ally of *Mastigoproctus* appears to be the eastern Himalayan genus *Uroproctus*. This fact, coupled with the occurrence of the family in China, points to its former existence throughout the countries bordering the North Pacific, when tropical or warm temperate conditions prevailed there. If this be so, the tropical American forms must be regarded as immigrants from the north.

One point connected with the distribution of the group in Central America is its apparent absence from the States to the south of Guatemala. Nevertheless, it occurs in the Greater and Lesser Antilles (Haiti, Martinique) and in Brazil. Possibly therefore it made its way from Central into South America by means of an Antillean route.

The Amblypygous Pedipalpi have a wider range than the Urotricha. In the Old World they are represented by two families, the Tarantulidæ (=Phrynichidæ) which range from Siam, through India, and Arabia into tropical and South Africa, but are absent from Madagascar, and the Charontidæ which have their headquarters in Further India, whence they spread westwards to the Seychelles and eastward to the Solomon Islands. Like the Urotricha they are absent from Australia *.

The suborder is represented in tropical and subtropical America by the family Phrynidæ, which is unknown in the Old World. Of the two subfamilies, the Heterophryninæ are essentially South American, but are unknown in the Antilles. One species, however, which for want of accurate determination I have provisionally referred to the Demeraran *H. chiracanthus*, has been recorded from Central America without further particulars as to locality.

The Phryninæ have a much wider range, extending from North America, throughout Central America and the West Indies, into South America. *Acanthophrynus* is known only from California and Mexico (Durango). Of *Phrynus*, one species ranges from Texas to Nicaragua; two occur in Guatemala and are not known elsewhere, and one in Panama, the latter being found also in Colombia, Venezuela, Trinidad, and Barbados. Other species occur in the Lesser and Greater Antilles and the northern part of South America. The third genus, *Hemiphrynus*, ranges from Mexico (Tuxtla, Oaxaca, Teapa, etc.), through Guatemala, Costa Rica, and Panama into South America. Although unknown in the Antilles, there is an outlying species in the Bahamas.

Conclusion.

The Pedipalpi supply no evidence of a mid-Atlantic land-connection between Africa and America, and none of the existence of a continuous or partial Antarctic land joining the southern continents. Nor in the case of America do they help much in the definition of the regions and subregions indicated by the Scorpions. One or two points may, however, be touched upon.

The occurrences of *Acanthophrynus* in California and Mexico, of *Phrynus whitei* in Texas and Mexico, of *Mastigoproctus giganteus* † in several of the Southern States of America and all over Mexico, affiliate the latter country faunistically with the southern portions of North America. The Sonoran area thus defined differs from South

* One species of Urotricha belonging to the genus *Thelyphonus* has, however, been recorded from Cape York, the extreme northern point of Australia.

† Since the Pedipalpi and Scorpions have existed from the Carboniferous with comparatively slight structural changes, they cannot be regarded as plastic organisms. In my opinion, therefore, species, genera, and families have greater significance from the geographical standpoint than groups of those ranks in the Mammalia.

America in the absence of *Heterophrynus* and of the Thelyphonid *Thelyphonellus*; but it is linked thereto by the extension of *Hemiphrynus* from Mexico to Colombia, and of *Phrynus* and *Mastigoproctus* from Texas at least as far as Brazil. The chief distinction between the Antilles and the Sonoran area is the absence of *Acanthophrynus* from those islands, and between the Antilles and South America the absence of *Heterophrynus*, *Thelyphonellus*, and *Hemiphrynus* from the former. But the occurrence of *Phrynus* and *Mastigoproctus* in both the Greater and Lesser Antilles, as well as in Mexico and South America, points to union between these islands and the countries in question.

Order SOLIFUGÆ.

With one exception the Central American genera of this Order show the same general geographical features as the Pedipalpi and some of the Scorpions. *Eremobates*, the type of a special subfamily, is restricted to the Southern States of North America and Mexico, its distribution coinciding tolerably closely with that of the Scorpion *Vœjovis* in the sense that neither extends into the West Indies or into South America. *Ammotrecha*, on the other hand, which also occurs in the Southern States of the Union, is found in the Antilles and in South America, its distribution being parallel to that of the Pedipalp genera *Mastigoproctus* and *Phrynus* and of the Scorpion *Centruroides*. The exception above referred to is *Hemiblossia*, one species of which occurs in Guatemala and the others in South Africa. This case of discontinuous distribution recalls that of the Scorpion *Opisthacanthus*, whose nearest allies are tropical and South African species.

Ammotrecha and *Hemiblossia* belong to a subfamily represented by numerous genera in Africa, South-western Asia, and the Mediterranean area of the Old World, but unrepresented in the Oriental Region and Eastern Asia. Their occurrence in Central America points to an Atlantic connection between the Old and New Worlds. The only other facts to be borne in mind in this connection are the records of a species of *Dæsia*, typically an African and Mediterranean genus, in Mexico, and of a species of the genus *Eremobates* in Afghanistan. Both these records, however, require confirmation.

Order ARANEÆ.

The Central American fauna of Spiders differs, as a whole, from that of the Scorpions and Pedipalpi in two particulars, namely, the vast number of species, genera, and families it is composed of and the large number of these that are common to the Old and New Worlds. Hence, within the limits of a short essay, it is impossible to deal with all the families concerned. To illustrate some of the main features of the fauna and to trace as far as may be its sources, I have selected therefore for detailed treatment

the sharply circumscribed suborder of the Mygalomorphæ. The mutual affinities of the genera and families of this group are sufficiently well understood for the purpose, and from the geographical standpoint it has the additional advantage of being, so far as we know, dependent upon continuous land-areas for its dispersal, since the species appear—for the most part, at all events—to be independent of the method of travelling commonly known as "ballooning," which the young of many of the families of Arachnomorphæ have been ascertained to practise shortly after dispersing from the cocoon. As has been suggested above (p. 119), the very wide, sometimes cosmopolitan distribution of some genera may perhaps be assigned to this cause, coupled with exceptional power of adaptation to highly varied conditions.

The Central American representatives of the Mygalomorphæ were referred by Mr. F. Cambridge to the three families, Ctenizidæ, Dipluridæ, and Theraphosidæ. This classification will be here adhered to in the main as sufficiently exact for the purpose in hand.

The first subfamily of the Ctenizidæ, the Actinopodinæ, is represented by the two genera, *Actinopus* and *Neocteniza*. The latter has only been recorded from Guatemala and Demerara. The former is abundant all over South America from the Argentine northwards to Venezuela, and enters Central America at Panama. Perhaps it awaits discovery in other tropical districts of Central America. It is interesting to record that the only other representative of this subfamily is the Australian genus *Missulena* (*Eriodon*).

The genera of the second subfamily, the Ctenizinæ, are referred to three sections, the Pachylomereæ, the Ctenizeæ, and the Cyrtauchenieæ. From the first of these should certainly be dismembered the genus *Chorizops* as the type of a very special group, the Cyclocosmeæ or Halonoprocteæ. This group contains the three genera: *Chorizops* recorded from Mexico (Guanajuato, Vera Cruz), *Cyclocosmia* from Alabama, and *Halonoproctus* from China.

The Pachylomereæ comprises three genera: *Conothele* ranging from Burma to the Solomon Islands, *Hebestatis* from California, and *Pachylomerus* itself. This genus has a remarkably discontinuous distribution. Several species occur in the Southern States of North America, in Central America from Mexico southwards to Guatemala and Costa Rica, and a few in the West Indies (Jamaica, St. Vincent). In the Old World it is met with in Japan, but, singularly enough, elsewhere only in the western Mediterranean (Spain, Algeria).

The genus *Bothriocyrtum*, the sole Central American representative of the Ctenizeæ, has one Mexican and one Californian species. Its nearest ally is *Cyrtocarenum* of the Mediterranean area. All the other genera of the Ctenizeæ are Old World forms, two, in addition to *Cyrtocarenum*, being Mediterranean, one South African, one Central Asian, and one Japanese and Chinese.

The Cyrtauchenieæ, the fourth and last group of the Ctenizinæ, has three Central American representatives, *Eutychides*, *Eucteniza*, and *Enrico*, all restricted to Mexico. One other genus, *Myrmekiaphila*, from Carolina and Virginia, occurs in the New World. Of the rest, four in number, one is Burmese, one (*Cyrtauchenius*) Mediterranean, and two South African.

The Central American forms of the Dipluridæ are referred to two subfamilies, the Diplurinæ and the Ischnothelinæ. The Diplurinæ, corresponding with Simon's group Diplureæ, have a very singular distribution. In South America there are about nine genera ranging from Chili northwards, *Fufius* the single Central American genus spreading into Costa Rica and Guatemala from Brazil, Ecuador, and Bolivia. Four genera occur in Australia, two in Madagascar, and one in the Mediterranean area.

The distribution of the Ischnothelinæ (=Macrotheleæ, *Simon*) is equally remarkable. There are two known Central American genera. *Evagrus* spreads southwards from Mexico and Guatemala to Bogota, and northwards into the United States (Idaho). One species, possibly generically distinct from it, has been recorded from South Africa. The nearest ally of *Evagrus* appears to be the Transcaspian genus *Phyxioschæma*, which is itself closely akin to *Stenygrocercus* from Australia and New Caledonia. Other less closely related genera occur in the Old World in the Mediterranean area, in tropical West Africa, Burma, China, and New Zealand. *Ischnothele* is a very distinct type from those above mentioned. It occurs in Mexico, Nicaragua, Guatemala, and the northern countries of South America, and in the Old World, in tropical Africa, Madagascar, and India.

The Central American genera of Theraphosidæ * have been revised since Mr. Cambridge described them. The species he referred to *Eurypelma* have been split up into a number of genera and are probably susceptible of further subdivision †. The species named *æmilia*, *pallidum*, *smithii*, and *vagans* belong to *Brachypelma*, which ranges from Mexico to Colombia in South America. Those named *rusticum* and *seemani* are referred to *Aphonopelma*, which extends from the Southern States of North America into Mexico and Costa Rica. The species described as *Eurypelma longipes* from Guatemala is the only known form of the genus *Citharacanthus*, which is allied to *Cyrtopholis*, a genus mainly confined to the Greater and Lesser Antilles, but represented in Central America by *C. pernix*, referred by Cambridge to *Hapalopus*, from Orizaba in Mexico. The genus *Dugesiella*, containing species from Texas and Mexico (Guanajuato) has been added to the Central American fauna since

* The Spiders of this family are those commonly referred to in textbooks and Natural Histories as *Mygale*, or "Bird-eating" Spiders.

† One of the species, *spatulatum*, was included owing to an error in locality. It belongs to the genus *Grammostola* (=*Citharoscelus*) and came from Chili. Another Chilian species that was entered and must also be eliminated is *Paraphysa manicata*.

Mr. Cambridge finished his account of the Spiders. So, too, has the genus *Psalmopœus*, which contains the Costa Rican species *reduncus* and others from Ecuador, Colombia, and Trinidad.

The genera *Sphærobothria* from Costa Rica, *Sericopelma* from Panama, and *Schizopelma* from Mexico and Costa Rica have not, so far, been discovered beyond the limits of Central America, but, like the others cited above, and the remainder recorded by Mr. Cambridge, they are related to South American or West Indian genera of this great family, and with one or two exceptions have no near kinship with the genera characteristic of tropical Africa, Asia, and Australia, which belong to distinct groups or subfamilies. Two apparent exceptions to this, however, must be mentioned. The South American genus *Avicularia* which extends into Panama belongs to a group to which also belongs the tropical West African genera *Scodra* and *Heteroscodra*; and the genus *Hemirrhagus*, represented by one species, *cervinus*, in Mexico, seems to have its nearest ally in *Cratorrhagus* of the Mediterranean area.

The conclusion suggested by the above-stated facts is this:—

The Central American Mygalomorphæ belong to two categories: (1) Those referable to groups which are in the main northern in distribution; (2) those referable to groups which are in the main southern in distribution.

1. To the northern group belong *Pachylomerus*, which occurs elsewhere in the West Indies, North America, Japan, and Spain; *Chorizops*, whose only known allies are found in North America and China; *Bothriocyrtum*, which occurs also in North America and is related to genera from Japan, China, Central Asia, and the Mediterranean area; *Enrico*, *Eutychides*, *Eucteniza*, akin to genera from North America, Burma, and the Mediterranean; *Evagrus*, ranging from North America to Bogota, is allied to genera from the Mediterranean region, West Africa, Transcaspia, China, and Burma. In the New World none of these groups is found south of the equator. In the Old World, however, genera akin to *Bothriocyrtum*, *Enrico*, *Eutychides*, *Eucteniza*, and *Evagrus* occur in South Africa, and others allied to *Evagrus* in Australia and New Zealand. Perhaps in the future these may be geographically linked with the northern types, but so far as our knowledge goes they are isolated.

2. To the southern groups belong *Neoctenizа*, from Demerara and Guatemala, and its ally *Actinopus*, which ranges from the Argentine into the West Indies and Panama and is related to the Australian genus *Missulena*, but to no other genus of the Old World; *Fufius*, extending from Brazil to Costa Rica and Guatemala, is related to many genera confined to South America and to others occurring in Madagascar and Australia, with one outlying form in the Mediterranean area; *Ischnothele*, ranging from the northern countries of South America into Mexico, is also met with in tropical Africa, Madagascar, and India; all the Central American genera of Theraphosidæ, some of which pass into the Southern States of North America, have their nearest allies in South America, where they occur at least as far south as the

Argentine and Chili. In the Old World their nearest allies, few in number, are found in West Africa and the Mediterranean.

Tentative explanations of these facts may be illustrated by one or two cases. If the groups to which *Chorizops* and *Pachylomerus* belong are North American in origin, they may have extended thence southwards into Central America and northwards into eastern Asia. *Pachylomerus*, in addition, may have passed eastwards from America to Spain and Algeria, or its apparent restriction in the Old World at the present time to such widely sundered areas as the south-western Mediterranean and eastern Asia may be attributed to its former extension over Eurasia and its survival only in those two localities. Against this hypothesis can only be urged the impossibility of assigning any cause for its extinction in other parts of the Asiatic district.

If the group to which *Actinopus* and *Eucteniza* belong was evolved in South America, these genera may have moved northwards into Central America; and the restriction of an allied genus to Australia may be assigned to the entry of the group into that country from South America.

Since tropical America is the headquarters of *Ischnothele*, judging from the number of indigenous species, it may be provisionally regarded as the original home of the genus. Thence it may have passed by a transatlantic bridge to Africa, and so to Madagascar and India.

These four genera of Mygalomorphæ, apart from others which might have been cited, supply evidence, such as it is, for direct land-continuity, under tropical or warm temperate conditions, between (1) North America and eastern Asia; (2) North, Central, or South America and the Mediterranean; (3) South America and tropical Africa; (4) South America and Australia.

Corroborative evidence for "Antarctica" is supplied by another family (or sub-family) of Mygalomorphæ, namely the Migidæ, which is related to the Ctenizidæ, but does not occur in Central America. It contains eight genera, distributed as follows:—*Moggridgea* and *Pœcilomigas*, South and South-east Africa; *Myrtale*, *Micromesomma*, and *Thyropœus*, Madagascar; *Heteromigas*, Tasmania; *Migas*, New Zealand; and *Calathotarsus*, Chili.

It appears to me to be impossible to assign any reason for the extermination of this group of Spiders in the northern portions of the continents to which they are now restricted, if the genera in question are the descendants of a family evolved sufficiently far to the north to have passed from the Old to the New World, or *vice versâ*, along a North Atlantic or North Pacific route.

Turning to the Arachnomorphæ, one or two of the Central American families may be selected to illustrate the restricted range of some and the wide range of others.

The Senoculidæ and Acanthoctenidæ, each represented by a single genus, are peculiar to America, ranging from South America northwards to Mexico. The Psechridæ are represented by two genera, *Psechrus* and *Fecenia*, in the southern and

south-eastern parts of Asia, an area to which they were believed to be restricted until the discovery of the genus *Metafecenia* in Central America (Guerrero in Mexico). The Deinopidæ (*Deinopis*), occurring in North, Central, and South America, is also found in tropical Africa, Madagascar, and South Asia. Of greater interest, because of their restricted range, are the families Sicariidæ and Caponiidæ, both very sharply defined groups, the latter being also in some respects highly specialized or progressive. The Sicariidæ range in America from Chile up the western portions of the continent as far as Costa Rica, and are only found elsewhere in the world in South Africa. Similarly with the Caponiidæ. Of the three genera, *Nops* occurs in South America and the Antilles, *Caponina* in the Antilles and Central America (Guatemala), while the related genus *Caponia* is South African. These families corroborate the evidence derived from other sources for a direct connection between Africa and South America.

The most prominent Spiders in the Central American fauna are those belonging to the web-spinning species of the family Argyopidæ. The distribution of some of the dominant genera of this family is as follows :—*Nephila* ranges from the warmer States of North America through Central America into South America, and is abundant all over tropical Africa, Asia, and Australia ; *Gasteracantha*, a hard-shelled spine-bearing genus, has nearly the same distribution as *Nephila*. The other hard-shelled spiny genus, *Micrathena*, is, however, restricted to America, where its range closely coincides with that of the two just mentioned. *Argyope* agrees closely with *Nephila*, but has a more northern distribution, at all events, in the Old World, where it reaches the Mediterranean area. Finally, the genus *Aranea* (= *Epeira*) is practically cosmopolitan, extending from north temperate, if not subarctic, latitudes southwards all over the continents.

These genera illustrate, as clearly as others which might have been selected, the wide distribution of a large number of the genera of Arachnomorphæ recorded from Central America.

CHILOPODA, DIPLOPODA, AND PROTOTRACHEATA.

By R. I. Pocock, F.R.S.

The Chilopoda and Diplopoda were in existence in the Carboniferous Period in Europe and North America. But since these ancient forms were different from their modern representatives, and since they afford no help to an understanding of the present distribution of these classes, it is needless to discuss them further, and useless to repeat what has already been said on this head in the introduction to the essay on the Arachnida.

Class CHILOPODA (Centipedes).

From the geographical standpoint the Chilopoda or Centipedes are remarkable for the wide distribution of the orders and of most of the families into which the class is divisible. It is probable, however, that when the group has been studied in greater detail, the number of families, especially of the Geophilomorpha, will be considerably increased and their distribution better understood. The recorded Central American genera of Geophilomorpha and of Scutigeromorpha call for no special comment in the present connection, since they exhibit no special features throwing light upon the origin of the fauna of that country. The Lithobiomorpha and Scolopendromorpha are more interesting.

The Central American species of the former order belong to the family Lithobiidæ, which, although of wide distribution with a few outlying species of the genus *Lithobius* in the Southern Hemisphere (India, Australia), is mainly northern, being spread all over Europe, Central Asia, and North America, and represented by a vast number of species in these continents. Hence it seems that the Central American representatives spreading through Mexico to Guatemala must be regarded as a northern element in the fauna of our area.

The classification of the Scolopendromorpha proposed in my report may be revised as follows :—

Family Cryptopidæ*.
  Subfamily Cryptopinæ (*Cryptops* †, *Theatops, Otocryptops, Scolopocryptops*).
  Subfamily Newportiinæ (*Newportia, Scolopendrides*).
Family Scolopendridæ (*Cupipes* †, *Rhombocephalus, Scolopendra, Parotostigmus, Rhysida* ‡).

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* Brölemann's examination of the type of *Scolopendropsis*, showing that the genus is closely related to *Pithopus*, proves that the presence of 23 pairs of legs cannot be regarded as a character upon which a group of family rank can be based. I therefore follow Kraepelin in associating *Otocryptops* and *Scolopocryptops* with *Cryptops*.

† Added by Kraepelin to the Central-American fauna since my report was written.

‡ In Kraepelin's Monograph of the Scolopendridæ (Jahrb. Hamb. Wissen. Arch. xx. 1903, p. 139), this genus, as expanded by that author, should have been named *Trematoptychus*, which antedates *Rhysida* by one year.

Of the family Cryptopidæ the genus *Cryptops* is cosmopolitan, and its discovery in Central America has no particular significance. *Theatops*, *Otocryptops*, and *Scolopocryptops* are more restricted in range. *Theatops* spreads from North America into Mexico, and has one species in the Mediterranean area. Both *Otocryptops* and *Scolopocryptops* are South, Central, and North American, Antillean, and Chinese, *Otocryptops* also extending in the Old World into the south-eastern portion of the Oriental Region (Philippines, Celebes, Java, New Guinea, etc.) *.

The Newportiinæ are peculiar to the New World, being plentiful in South and Central America and the Antilles and represented by one species in North America. The two genera referred to the subfamily appear to be specialised forms of Cryptopidæ; and, judging from their present distribution, they were probably evolved in tropical America.

Two of the genera of Scolopendridæ demand particular attention—namely, *Parotostigmus* and *Scolopendra*. The former is mainly tropical American, occurring in South and Central America and the Antilles, but a few allied forms inhabit tropical Africa. Of greater interest are the species to which in 1903 (Nat. Hist. Sokotra, p. 429) I restricted the term *Scolopendra* †. This genus, as here limited, ranges from the Southern States of North America, through Central America and the Antilles, into the northern parts of South America and the Galapagos Islands. Elsewhere it has only been recorded from the Canary Islands, the Kameruns, Arabia, Syria, Persia, Sokotra, and the adjoining island of Abd-el-Kuri. Its distribution, therefore, coincides very closely with that of the Diplocentrine Scorpions, and is suggestive of a direct land-connection across the tropical Atlantic between the Old and New Worlds.

The Chilopod fauna of Central America shows marked affinities with that of North America, Asia, and Europe (*Lithobius*); with Eastern Asia (*Otocryptops*, *Scolopocryptops*); with tropical Africa (*Parotostigmus*); and with the Mediterranean area (*Scolopendra*, *Theatops*). But there are no data justifying any conclusion as to the original home of the genera in question, unless superiority in number of species be regarded as a criterion on that head. If this somewhat unsafe basis for an opinion be adopted, the inference is that all the genera, except the northern *Lithobius*, were evolved in tropical America, and subsequently entered the continents of the Old World where they are now found.

* One species of *Otocryptops*, abundant in South and Central America and the Antilles, has also been recorded from West Africa. There is no proof, however, that the species was not transported, probably in connection with the slave trade, as I have suggested.

† Nearly all the Central American species belong to this genus. The two aberrant forms, *punctiventris* and *pygmæa*, should perhaps be regarded as representing distinct genera and need not be considered in the present connection.

Class DIPLOPODA (Millipedes).

The dominant Central American forms of the Calobognatha or suctorial millipedes belong to the genus *Platydesmus* of the family Platydesmidæ. This family also has representatives in North America, Amurland, Malaysia, and the Mediterranean area in Europe. It has not been recorded as yet from tropical Africa, India, or Australia. Hence the known facts of its distribution point to its evolution in the Northern Hemisphere and to its failure to penetrate into the ancient southern continents. If the Mediterranean species referred to *Platydesmus* belong, as is probable, to a distinct genus, *Platydesmus* is restricted to Central America (Mexico, Guatemala).

The Chordeumoidea are divisible into two families—the Heterochordeumidæ, ranging from India to New Zealand, and the Chordeumidæ, which are abundant in North America and Europe. Their range eastward from Europe into Asia has not been ascertained, but there seems no doubt that they are absent from tropical Africa.

The described Central American species, from Mexico and Guatemala, belong to a genus (*Cleidogona*) also existing in North America. No species have been discovered in South America or in the Antilles. This element, therefore, of the Diplopod fauna of Central America was no doubt derived from North America.

The Stemmiuloidea are an obscure group, known at present only from tropical Asia (Ceylon), tropical Africa (Liberia), and tropical America (Colombia, Panama, and Porto Rico). Probably these Diplopods await discovery elsewhere; but, so far as is at present known, they may be described as southern. Perhaps the most interesting point connected with their distribution is the ascription to the same genus (*Diopsiulus*) of the Ceylonese, Liberian, and Porto Rican species. This classification accords with the theory of the former existence of a tropical transatlantic connection between the Greater Antilles and West Africa.

The Central American forms of Iuloidea, *Paraiulus*, from Mexico and Guatemala, are closely akin to genera and species now living in North America. The nearest ally of *Paraiulus* in the Old World is *Mongoliulus*, recorded from Corea. Here again there is evidence for a northern derivation of this element of the Central-American fauna.

As an explanation of the occurrence of the suborder in North America and Europe, it may be suggested that it formerly extended across the Northern Atlantic when temperate conditions prevailed in Greenland, Iceland, and the now-vanished land-areas which are believed to have joined these countries and Europe and America in one continuous tract.

Of the Spirostreptoidea, the single Central American genus of Spirostreptidæ (*Orthoporus*) is mainly South American in distribution; but it is closely allied to, if not identical with, millipedes of the same family now found in tropical Africa, but not

apparently in tropical Asia. The most plausible explanation of these facts is that *Orthoporus* and its near allies were evolved in a continent embracing and connecting South America and tropical Africa, and that *Orthoporus* moved northwards into Central America after the formation of the isthmus of Panama. In Central America the genus ranges from Panama to Mexico.

Like *Orthoporus*, the genus *Epinannolene* also appears to be South American in its affinities.

Although the precise geographical range of the two dominant Central American genera of Spiroboloidea, namely *Rhinocricus* and *Spirobolus*, has yet to be ascertained, one or two facts of interest may be noticed.

Spirobolus, ranging from Mexico to Guatemala, occurs also in the Southern States of North America and in Eastern Asia as far north as Pekin. It is not abundant in the West Indies, although recorded from Porto Rico. It is apparently absent from South America. The evidence, therefore, is in favour of a northern, rather than a southern, origin for this genus.

Rhinocricus, on the other hand, is abundant in South America and the West Indies, but not in North America. In Central America it extends from Panama to Mexico. It is also the dominant genus of the family Spirobolidæ in the Oriental Region, but does not appear to extend in Eastern Asia so far north as *Spirobolus*. Clearly, therefore, it is a more southern type than the latter.

There is at present no agreement amongst systematists as to the number of families into which the Polydesmoidea should be divided, but, setting aside some of the peculiar forms referred to below, sufficient is known of the inter-relationship of some of the other genera to make instructive comparison between the Polydesmoid fauna of Central America and that of other countries.

The most important of these belong to the families Platyrhachidæ and Chelodesmidæ.

The two subfamilies of Platyrhachidæ are represented in the tropical south-eastern countries of Asia, the Platyrhachinæ being especially abundant in Malaysia. They are not represented in tropical Africa. In America they inhabit the northern countries of South America, particularly Colombia and Ecuador, whence the Platyrhachinæ extend northwards, at all events, to Costa Rica, and occur in the Antilles; whereas the Euryurinæ have a much more northern extension, passing from Costa Rica, through Guatemala and Mexico, into the Southern States of North America.

The Chelodesmidæ are very wide-ranging, but from our present point of view the most interesting forms are the species of the dominant Central American genus *Rhysodesmus* of the subfamily Xystodesminæ. This genus is represented by a vast number of species in the northern districts of Central America, but is apparently absent in South America and in the Antilles. It extends into North America, and closely allied, if not generically identical, forms occur also in China.

The Central-American Diplopods, from the faunistic standpoint, belong to three categories: (1) genera with northern affinities and probably derived from the north; (2) genera with southern affinities and probably derived from the south; (3) genera restricted or almost restricted to the country and probably autochthonous.

The principal groups of northern origin are the Platydesmidæ (*Platydesmus*), the Chordeumidæ (*Cleidogona*), the Iuloidea (*Paraiulus*); *Spirobolus* of the group Spiroboloidea and *Rhysodesmus* of the Xystodesmine Polydesmoidea.

To the group with southern affinities and probably of southern origin must be referred the Spirostreptoidea (*Orthoporus* and *Epinannolene*), the Stemmiuloidea (*Stemmiulus*); *Rhinocricus* of the group Spiroboloidea and several of the Polydesmoidea, like *Ligiodesmus*, *Oncodesmus* (Oniscodesmidæ), *Lophodesmus* (Pyrgodesmidæ), *Platyrhachus*, *Amplinus*, and others (Platyrhachidæ). Of these, *Orthoporus* and probably *Epinannolene* have African affinities; the Stemmiuloidea and Pyrgodesmidæ also have related genera in tropical Africa and Asia. On the other hand, the Oniscodesmidæ and Platyrhachidæ are at present known only from South-Eastern Asia and tropical America. The Oniscodesmidæ may await discovery in Africa, but the Platyrhachidæ appear to be certainly absent from that country. Their restriction to Indo- and Austro-Malaysia and tropical America is singular. Nevertheless, since their distribution agrees in a measure, though not in exact detail, with that of the existing Tapiroid mammals, it may be that they are tropical survivors of families once extending throughout the countries now bordering the North Pacific Ocean.

Of the peculiar, probably autochthonous, groups, the most interesting are the Polydesmoidea of the family Sphæriodesmidæ, which appear to be a specialised offshoot of the Chelodesmidæ. The family ranges in Central America from Mexico to Costa Rica, and one of the genera, *Cyclodesmus*, is also represented in Jamaica. Also apparently restricted to Central America, with the exception of one form recorded from California, are the genera of the Chelodesmidæ belonging to the subfamily Rhachodesminæ.

Class PROTOTRACHEATA.

No fossil forms of this class are known. On morphological grounds it is believed to be of great antiquity, older even than the Trilobites, but, as Gadow has pertinently remarked:—"This genus [*Peripatus*] need not date further back than the Cretaceous to allow us to account for the scattered distribution of its species" *.

Until 1894 all the described species of this Class from South America, South Africa, and Australia, were referred to the single genus *Peripatus*, despite the ascertained existence of important morphological differences between those of the Continents in question. But since that date, when it was first proposed to give new generic names

* Gadow here ignores the work of Bouvier and others, who refer the Prototracheata to several genera.

to the South African and Australasian groups, and to restrict the original title to the South American groups, great additions have been made to our knowledge of this Class, mainly by the discovery of new genera, but partly by a more detailed acquaintance with species that had been previously described. One practical outcome of these lines of research has been rapid development of the classification from the point of view of nomenclature, with the result that there appears to be at least eight well-marked genera distributed as follows:—

I. South and Central America and West Indies.
Peripatus. Tropical America.
Opisthopatus. Chile.

II. Tropical and South Africa.
Peripatus. Congo.
Opisthopatus. South Africa.
Peripatopsis. South Africa.

III. East Indies.
Typhloperipatus. Abor country, N.E. India.
Eoperipatus. Sumatra, Malay Peninsula.

IV. Australasia (including Australia, New Zealand, New Guinea, etc.).
Paraperipatus. New Guinea, Solomon Islands.
Peripatoides. Australia and New Zealand.
Ooperipatus. Australia and New Zealand.

With exception of *Typhloperipatus*, described in 1913, these genera were admitted by Bouvier in his Monograph of 1907–8. For my present purpose it is immaterial that one of the species referred by Bouvier to *Ooperipatus* has been recently given generic rank, under the name *Symperipatus* by Cockerell, and that the species from the Congo and Chile, assigned by the French author respectively to *Peripatus* and *Opisthopatus*, have been separated from those genera as *Mesoperipatus* and *Metaperipatus* by Clark *. The interesting point in this connection is that close relationship exists, on the one hand, between the tropical African and tropical South American species and, on the other hand, between the Chilian and one of the South African forms. Clark's further proposals regarding the generic and subgeneric divisions, to which he refers the tropical American species assigned by Bouvier to *Peripatus* will be referred to later on.

* It will be a nice controversial question for systematists to settle in the future whether the names "Congo-Peripatus" and "Chilio-Peripatus," proposed by Sedgwick for these same species, shall be admitted as generic terms or not. Clark, perhaps not wisely, disregarded them, probably because Sedgwick, true to his colours, expressly disclaimed the intention of putting them forward as generic terms. But since they were available as properly published names, future disputation would have been avoided by accepting them.

Three classifications of the genera into families and subfamilies have been put forward by Evans, Bouvier, and Clark. That of Clark, which is a compromise, with amplifications, between the other two, will serve to show the mutual relationships of the genera above mentioned admitted at the present time:—

Family Peripatidæ.
  Subfamily Peripatinæ.
    Genus *Peripatus* (*Mesoperipatus*). Tropical America and Africa.
  Subfamily Eoperipatinæ.
    Genus *Eoperipatus*. Sumatra, etc.
    Genus *Typhloperipatus*. N.E. India.

Family Peripatopsidæ.
  Subfamily Peripatopsinæ.
    Genus *Peripatopsis*. S. Africa.
    Genus *Paraperipatus*. New Guinea, Solomon Islands.
  Subfamily Peripatoidinæ.
    Genus *Peripatoides*. Australia and New Zealand.
    Genus *Ooperipatus*. Australia and New Zealand.
    Genus *Opisthopatus* (*Metaperipatus*). Chile, S. Africa.

Attention may be drawn to one or two interesting faunistic points revealed by this arrangement:—

1. Resemblance, in the case of the Peripatidæ, between the Malaysian forms and those of tropical West Africa and of tropical South America. This case is closely paralleled by that of the dwarf Squirrels, Nanosciuridæ, amongst the Mammalia.
2. The restriction of the genera of Peripatoidinæ to Australia, New Zealand, Chile, and South Africa.
3. The ascription of the Papuasian genus and one of the South African genera to the same subfamily, Peripatopsinæ. These genera, however, are not very closely allied.

The Central American Species.

Bouvier pointed out in his Monograph that the tropical American species of *Peripatus* fall into two groups, which he named *Péripates andicoles* and *Péripates caraibes*. To the former, restricted to the mountains of Central America and the northern Andes, Cockerell gave the name *Oroperipatus*, limiting the term *Peripatus* to those found in the West Indies and lower-lying countries of South and Central America. This genus was subsequently divided by Clark into the following subgenera:—*Plicatoperipatus*, known from one species (*jamaicensis*) from Jamaica; *Macroperipatus*,

containing species ranging from Rio Janeiro to Central America; *Epiperipatus*, also containing many species with approximately the same distribution as *Macroperipatus*; and *Peripatus* (s. s.), restricted to species extending from Jamaica through the West Indies to Venezuela.

Oroperipatus, occurring elsewhere in the Andes of Bolivia, Ecuador, and Colombia, is represented by two species in Central America, namely *O. eiseni* from Tepic in Mexico and *O. goudoti* from Mexico, without further particulars as to locality, although, as Bouvier suggested, it probably came from the western mountains of that country.

Peripatus has many Central American representatives, namely *perrieri*, from Vera Cruz in Mexico, *geayi*, ranging from Cayenne to Panama, both belonging to the subgenus *Macroperipatus*; *biolleyi* and *isthmicola* from Costa Rica; *nicaraguensis* from Nicaragua; *edwardsii*, extending from Cayenne and Venezuela to Darien and Panama, and *brasiliensis*, extending from Santarem on the Amazons to Panama, these five being referred to the subgenus *Epiperipatus*.

It may be noted that *Oroperipatus* and *Macroperipatus* are absent from the Antilles, and that only one representative of *Epiperipatus* has hitherto been recorded from those islands, namely from Grenada, the southernmost of the chain*. On the other hand, *Plicatoperipatus* and *Peripatus* (s. s.) are absent from Central America; while the latter subgenus, exemplified by peculiar species in Jamaica and Porto Rico and in most of the islands of the Lesser Antilles, exists also in Venezuela.

Conclusions.

The Prototracheata are at the present time restricted to tropical and south temperate latitudes. They have become adapted to widely different conditions so far as temperature and climate are concerned. Their extension in the Southern Hemisphere about as far as the 45th parallel (Tasmania, New Zealand, Isle of Chiloe), and their existence at high altitudes within the tropics precludes the belief that their apparent absence from southern temperate areas in the Northern Hemisphere is due to inability to maintain themselves to the north of the Tropic of Cancer or thereabouts. The evidence therefore is in favour of the view that the Class was southern in origin.

The present distribution of the genera *Peripatus* (*sensu lat.*) and of *Opisthopatus* (*sensu lat.*) attests a former union between Africa and South America. The last-mentioned genus also attests, though less strongly, a union between Australasia

* This instance recalls the occurrence of the Armadillo (*Dasypus*) in Grenada, alone of all the Antilles.

and South America, since its affinities appear to lie with the Australasian *Peripatoides*.

In the case of the tropical American forms, it seems probable that Central America and the Antilles independently received their prototracheate faunas from South America.

Recent Literature.

Bouvier, E. L.—Ann. Sci. Nat. Zool. (9) ii. pp. 1–376 (1905) *, and v. pp. 61–318 (1907).

Sedgwick, A.—Quart. Journ. Micr. Sci. lii. pp. 379–406 (1908).

Clark, A. H.—Smith. Misc. Coll. lx. no. 17, pp. 1–5 (1913); id. Proc. Biol. Soc. Wash. xxvi. pp. 15–20 (1913).

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* In justice to Mr. F. O. Pickard Cambridge, it should be explained that in Bouvier's Monograph, figg. 1 and 2, pl. i., depicting examples of *Peripatus simoni* from Breves on the Amazons, are reproductions of water-colour sketches taken from life by Mr. Cambridge, who collected the specimens at that locality. The sketches were sent, with the specimens, to Bouvier from the British Museum, but apparently without any indication that Mr. Cambridge was the artist and collector.

Appendix.

The recently published paper by W. D. Matthew, entitled "Climate and Evolution" (Ann. New York Acad. Sci. xxiv. pp. 171–318, Feb. 1915), came to hand after the Mammalian section of this work was in type and after the sections dealing with the Arthropoda were written. Two of the main propositions of this thesis have an important bearing upon suggestions that have been put forward to explain some of the facts in the distribution both of the Mammals and of the Arthropods:—

1. "The principal lines of migration in later geological epochs have been radial from Holarctic centres of dispersal." (P. 172.)
2. "The numerous hypothetical land-bridges in temperate, tropical, and southern regions, connecting continents now separated by deep oceans, which have been advocated by various authors, are improbable and unnecessary to explain geographic distribution. On the contrary, the known facts point distinctly to a general permanency of continental outlines during the later epochs of geologic time, provided that the allowance be made for the known or probable gaps in our knowledge." (P. 173.)

As regards the Mammalia, mentioned in this part of the 'Biologia,' whose distribution is tentatively assigned to vanished land-bridges, Mr. Matthew holds the following opinions. The resemblance between *Thylacinus* and the extinct South American Sparassodont Marsupials, believed by some American palæontologists to indicate close affinity, is held by Mr. Matthew to be adaptively convergent (p. 265); and Mr. Tate Regan has quite independently come to this conclusion (British Antarctic 'Terra Nova' Exped. 1910, Zoology, i. no. 1, pp. 41–43, 1914).

Mr. Matthew thinks that the ancestors of the Australian Marsupials entered Australia by way of Southern Asia, while those of the South American forms came down from North America. Mr. Matthew ascribes the absence of fossil Marsupials from Asia to the "imperfection of the geological record," and does not discuss either their comparative paucity in the Austro-Malayan Islands or their absence to the west of Wallace's Line—facts, which in my opinion suggest evolution in Australia, followed by northward migration into Austro-Malaya. Since the Didelphyidæ have survived in South America since the invasion of higher placental types, and have even successfully penetrated into North America, it seems to me that the disappearance of the Marsupials from Holarctica and their absence at the present time from Indo-Malaya can only be provisionally assigned to the unsuccessful competition with more

highly organised groups. However, since the hypothesis of the South Pacific land-bridge, so far as mammals are concerned, rests largely upon the alleged closeness of relationship between *Thylacinus* and, e. g., *Prothylacinus*, the question need not be further discussed until the debated point is settled, if capable of settlement, by the osteological experts concerned.

The difficulty of the South American Monkeys Mr. Matthew also surmounts by appealing to convergent evolution (p. 216). That is to say, the resemblances between the Monkeys of the Old and New Worlds have been independently acquired from Asiatic and South American Lemurs respectively.

This possibility was long ago considered, and rejected, by Mr. Beddard, but was adopted by Dr. Scharff. The supposed South American Lemurs—Mr. Matthew admits that this group is "very doubtfully represented in the early Tertiary formations of the Argentine"—must have passed, he thinks, into South America from North America during the Eocene, if I understand him aright. However that may be, I agree with Mr. Beddard that it is difficult to believe that the relationship between the Cebidæ and Simiidæ is no closer than Mr. Matthew suggests.

In connection with the Hystricomorpha, Mr. Matthew admits that "we find serious difficulties" (p. 229). After discussing the question, he concludes: "I have been unable to frame any hypothesis which will fit all the facts of the distribution of this group, except by assuming that the South American Hystricomorpha . . . . . reached South America from Africa in the Oligocene by over-sea raft-transportation. This involves so long a voyage that I hesitate to accept it as a reasonable probability, even though the winds and currents obviously favor transportation in this direction" (p. 231). Since this suggestion does not seem to be seriously entertained by its propounder, it does not call for further comment.

The presence of Manatees in the tropical rivers of West Africa and tropical East America is explained by the hypothesis of the former existence of the genus up the eastern and western shores of the Atlantic into the Arctic Ocean, to a point where his map (p. 174) shows the extreme north-eastern corner of Greenland may have been connected with the north-eastern corner of Europe—that is to say, almost to the pole. This theory will certainly account for the facts; but, until the genus *Trichechus* turns up in far northern Tertiary deposits, there is no direct evidence to support it.

Although Mr. Matthew deals mainly with the Vertebrates, he remarks in connection with the supposed transatlantic bridge between Africa and South America: "The supposed evidence in its favour from lower vertebrates and invertebrates is due, so far as I have been able to examine it, to a lack of appreciation of the principles of dispersal of races and of parallelism and of the imperfection of the geological record" (p. 231). Presumably he holds the same opinion regarding the supposed bridge between South America and Australia. Nevertheless, I cannot bring myself to believe

that the close likeness between the Australian Scorpion *Cercophonius* and several South American genera nor the resemblances between the genera of trap-door Spiders referred to Migidæ (p. 131) are due to parallel evolution. Nor is it at all intelligible to me why the Scorpions and Spiders in question have disappeared entirely from all parts of the world except the southern continents, if at one time they were Holarctic in distribution. Nor can I think that raft-transportation will account for their present discontinuous range. Whether the land-bridge theory is the true explanation is, of course, quite another matter; but it appears to me to be the least improbable of the four *.

* Elevations of ocean-floors to connect continents are usually regarded as vast changes. From the human standpoint the epithet is justifiable; but, if the diameter of the earth be taken as a standard, such changes may be described as infinitesimal.

FLORA.

By W. Botting Hemsley, LL.D., F.R.S.

Since the publication of the Appendix and Introduction to the "Botany" of the 'Biologia Centrali-America,' in 1888, botanical explorers have been very active, not only within our limits and in the contiguous countries, but also more especially in Africa and Eastern Asia, from Burma and China, southward and eastward, through the Malayan Archipelago to the Philippines, New Guinea, and Fiji.

The addition of new species to the Central American Flora is enormous, especially from Mexico and Guatemala *. Of new genera, established on newly discovered types, there are relatively few; but very many new genera have been founded by the segregation of old and familiar genera.

Notable among the discoveries in tropical and subtropical districts are additional genera and species of southern types or families, belonging to the Vochysiaceæ, Trigoniaceæ, Lecythidaceæ, Lauraceæ, Euphorbiaceæ, Artocarpaceæ, etc., etc.

The identification of Schlechtendal's Mexican genus *Julianiа*, the discovery of several new species of this genus, and the founding of the family Julianiaceæ, including the exceedingly rare and imperfectly known Peruvian monotypical *Orthopterygium*, constitute a most interesting botanical contribution.

But, taken on the whole, the internal discoveries throw no further light on phytogeography than we possessed in 1888. So little was known of the natural history of Lower California that it was not included in the 'Biologia,' though politically and geographically belonging to Mexico. It has since been sufficiently explored, as well as the outlying islands of Guadalupe, the Revillagigedo Group, and others, to reveal the characteristics of the vegetation and flora, which are essentially Sonoran, with an intermixture in the north of Upper Californian species. The endemic element, alike in the Peninsula and the Islands, is of no greater proportion than that of the adjacent mainland. American botanists have devoted much time to the investigation of the vegetation of North Mexico and of the States and Territories north-west of Mexico with extremely interesting results, emphasising the distinct origin of the Pacific and Atlantic floras.

* We have no statistics, except those kindly furnished for Guatemala by Captain John Donnell Smith, who, in his own publications, has added eighty-four genera and 1224 species not included in the 'Biologia.' Eleven of the genera and 488 of the species are new. It may, however, be safely assumed that about 2000 genera of flowering plants are represented in Central America by at least 15,000 species.—W. B. H.

Outside of America, the exploration of Central Africa has yielded the most startling results. Contrary to expectation, the relationships between the African and American floras are almost as strong as those between the African and Asiatic floras, including representatives of such otherwise exclusively, or almost exclusively, American families as the Canellaceæ, Caricaceæ, Humiriaceæ, Hydnoraceæ, Loasaceæ, Mayacaceæ, Napoleonaceæ, Rapateaceæ, Strelitziaceæ, Velloziaceæ, and Vochysiaceæ. There are equally striking generic and specific connections. Altogether there are records of the same, or specially representative, genera and species belonging to upwards of sixty families or distinct groups. These facts, coupled with the zoo-geographical data and the palæontology of the region, have given rise to the theory of a land-connection between Africa and South America in Eocene times, a theory accepted by both botanists and zoologists of high repute. Von Ihering's projected map of the assumed "Verteilung von Land und Meer zur Eocän-Zeit" offers a plausible solution of some of the problems of the present longitudinal distribution of organisms, alike in southern latitudes and in remote islands. As long ago as 1885 (Introduction to the Botany of the 'Challenger' Expedition), I rejected the theory of the vegetation of remote volcanic islands and groups of islands, such as the Galapagos and Hawaii, being necessarily of derived origin rather than remnants of a former wider flora. This view does not exclude dispersal by various agencies in distant parts of the world and natural migrations across the widest continents, as exemplified by some certainly introduced plants.

The explorations of the last twenty years in Western and Central China furnish further evidence of the existence of close relationships between the floras of eastern temperate Asia and eastern North America. Types illustrating this feature are usually representative species of near affinity, as, for example, of the genera *Liriodendron*, *Liquidambar*, and *Sassafras*. This American-Asiatic element extends southward to Mexico, and is more prominent in the mountains of eastern South Mexico than it is in the north. The following genera of forest-trees represented in the Atlantic States, absent from the Pacific States, reach Mexico, namely:—*Magnolia*, *Asimina*, *Tilia*, *Robinia*, *Liquidambar*, *Ilex*, *Diospyros*, *Bumelia*, *Ulmus*, *Celtis*, *Morus*, *Ostrya*, *Carpinus*, and *Carya*. In a general sense, the western coast-forests are coniferous and the eastern deciduous. Certain genera are apparently now confined, or nearly so, to America and the Mediterranean region (including the Azores and Canaries)—such are *Helianthemum*, *Lupinus*, *Heberdenia*, *Platanus*, and *Corema*.

Apart from the subantarctic flora, there are genera that extend from Chili to Mexico and from Australasia to Borneo. The magnoliaceous genus *Drimys* belongs to this category. Judging from analogies, this is an example of a northern extension of a southern type. The Proteaceæ, now almost exclusively confined to the Southern Hemisphere, furnish a similar instance in the closely allied genera *Helicia* and *Roupala*. The former ranges from Australasia to China, Japan, and India, the latter from Brazil to Mexico, and neither has further extensions. Of course, the absolutists

would regard these as tardy stragglers in a southern migration. The phanerogamic flora of Central America (as calculated in 1888) comprised an intermixture of northern and southern types of varying proportions in different areas and an autochthonous element. The last constituted only eleven per cent. of the genera against seventy per cent. of the species. The percentages of genera restricted to America and of wider ranges were 53·7 and 46·3 respectively. For species the figures stand at 89·9 per cent. restricted to America and 10·1 per cent. extending beyond America.

The statistics of a specimen of the upper mountain-flora comprise 260 genera, of which eighty-two (or 31·6 per cent.) were restricted to America, thirteen (or 5 per cent.) endemic within our limits, and the rest, 165 (or 63·4 per cent.), had extra-American extensions.

Nine of the exclusively American genera had northern extensions; twenty-five had southern extensions; twenty-two were common to the Andes only; and twenty-six were also represented in both North and South America.

The total number of species enumerated is 604, whereof 504 (or 83·4 per cent.) were reckoned as endemic; 83 others (or 13·8 per cent.) not extending beyond America, with a residue of only 2·8 per cent. of wider range. The extensions to other parts of America are given as: N. America, 17; S. America, 19; Andes only, 39; N. and S. America, 8. Of course, most of these figures are rough approximations, but they are sufficient to show that the representatives of northern and southern types are nearly balanced, and that the Andine element in the mountain-flora of Central America preponderates over the temperate northern element *.

Taking the whole phanerogamic flora of Central America, as it was known in 1888, 638 of the genera had north-western extensions, 562 north-eastern connections, whilst 1285 had southern extensions. Species yielded similar proportions. But statistics alone explain very little.

The present complexities of plant-distribution point to greater and oftener repeated alterations in the distribution of land and water than is generally admitted, and no one theory is sufficient, in my estimation, to account for the origin and progressive dispersal of organisms. Indeed, it is doubtful whether sufficient evidence still exists to carry us to a convincing conclusion. There is always the great question whether organic as well as inorganic matter has not developed on the same or similar lines in different regions or centres. Comparing the following particulars of the distribution of families, it is difficult to realize that one part of the world has produced a land-vegetation wholly different in composition from that of any other part. Very diverse interminglings exist, but they give little or no clue to the beginnings.

Accepting, for purposes of comparison, the number of families of flowering plants at 290, as defined in the seventh edition of Engler's 'Syllabus,' very nearly three-fourths are represented in both the Eastern and Western Hemispheres. In the more

* *Cf.* Biol. Centr.-Am., Botany, iv. p. 299 (1887).

restricted sense of Bentham and Hooker, four-fifths are common to both Hemispheres. The families confined to America are twenty-five in number, namely, Batidaceæ, Bromeliaceæ, Calyceraceæ, Cannaceæ (Scitamineæ *), Caryocaraceæ (Ternstrœmiaceæ), Columelliaceæ, Cyclanthaceæ, Cyrillaceæ, Fouquieraceæ (Tamariscineæ), Gomortegaceæ, Lacistemaceæ, Leitneriaceæ, Lennoaceæ, Limnanthaceæ (Geraniaceæ), Malesherbiaceæ, Marcgraviaceæ (Ternstrœmiaceæ), Martyniaceæ (Pedalineæ), Myzodendraceæ, Quinaceæ, Sarraceniaceæ, Thurniaceæ, Tovariaceæ (Capparidaceæ), and Tropæolaceæ (Geraniaceæ).

The foregoing families are of various categories. Eleven of these are limited to a single genus each, and the Bromeliaceæ is the only one exhibiting a considerable development of genera and species, now numbering forty-five and about a thousand respectively, generally dispersed in tropical and south temperate America. Twelve out of these twenty-five families are not known to be represented within the limits of the 'Biologia.'

Fourteen families are peculiar to the African region (including Madagascar and the Mascarene Islands), so far as known, eight of which are monogeneric. The only one of considerable development is the herbaceous Selaginaceæ, associated with the Scrophulariaceæ by Engler. The Chlænaceæ, comprising six genera and about twenty-five species, are peculiar to Madagascar. They belong to the Malvales, and are shrubs and small trees with showy flowers.

A group of small and interesting families inhabiting eastern Asia, consisting of the Cercidiphyllaceæ, Eucommiaceæ, Pentaphylacaceæ, Stachyuraceæ, and Trochodendraceæ, of remarkable affinities, is not represented in North America, but Engler places *Pentaphylax* near the American Cyrillaceæ.

In spite of its highly differentiated vegetation, the Australian flora counts few peculiar families; indeed, the only ones absolutely limited to Australia are the Cephalotaceæ, restricted to the singular *Cephalotus follicularis*, the Eupomatiaceæ and the Tremandraceæ, allied to the Pittosporaceæ, which, except the widely spread genus *Pittosporum*, are all Australian. But there are some characteristic Australasian (including New Zealand, New Caledonia, etc.) families with a few solitary outliers—such are the Centrolepidaceæ, represented by one species in China and one or two species in the extreme south of America, and the Epacridaceæ, with a few outliers in Malesia and Polynesia, and the monotypic *Lebetanthus* in Fuegia. The Eucryphiaceæ (*Eucryphia*), limited to about four species in Australasia and Chili, and the somewhat numerous and generally dispersed Australian Stylidiaceæ are represented outside of Australasia by solitary outliers only in India, Malaya, and Fuegia.

In addition to the above-named families, there are some twenty-five others peculiar to the Old World (with some extensions in Polynesia), but inhabiting two or more of

* The family-name under which the groups in question appear in the "Botany" of the 'Biologia.'—W.B.H.

the great divisions of the Eastern Hemisphere. No fewer than fourteen of these are monogeneric and inconspicuous in the vegetation, except *Casuarina* and *Nepenthes*. *Casuarina* and Pandanaceæ are prominent and widely spread in maritime districts, yet they have not reached America independently of human agency. The Flagellariaceæ and Philydraceæ also largely affect coastal regions. The arboreous Dipterocarpaceæ, numbering some 300 species, is the only large family in this category, and it forms a conspicuous feature in the forests of India and Malaya—rare in Africa, and apparently absent from Australia.

Including the families respectively nearly or quite peculiar to Africa, to Eastern Asia, and to Australasia, there are fifty-three families in the Old World which are not represented in America, as against twenty-five restricted to the New World.

From the foregoing particulars of distribution it is evident that harmonies do not exist on a large scale in the same way that obtains, for example, in the different islands of the Galapagos Archipelago. The peculiarities of plant-distribution are infinite and reducible to no laws: take, for illustration, the composition and present distribution of the families of root-parasites in relation to their affinities—the widely spread Balanophoraceæ and Orobanchaceæ and the local Lennoaceæ of North Mexico, or such essentially insectivorous families as the Nepenthaceæ of the Old World and the Sarraceniaceæ of America and the widely spread Lentibulariaceæ. One might go on multiplying the exposition of the anomalies and curiosities or phenomena of distribution. But just one more example: the Lardizabalaceæ comprise about half-a-dozen small genera, several of them distinct monotypes; two of the genera are endemic in Chili, and the rest of the order is restricted to North India, China, and Japan.

Mr. R. I. Pocock, in his account of the Mammalia, seems to have arrived at the same inconclusive results as myself in respect of the plants; but he evidently favours a former southern land-connection as a solution of the main problem, and, barring independent developments of life, it is the only theory that commends itself to my mind. No other explanation seems adequate *.

* It was originally planned to discuss more fully in this place the composition and origin of the Central American Flora, and at least six months were devoted to the collection of materials for this purpose; but a combination of adverse circumstances has hitherto hindered the completion of the work and rendered it impossible within the immediate future. It is a great disappointment to me that I could not furnish Dr. Godman with something in my line more worthy of his monumental publication.

I have great pleasure in recording the fact that I have received much assistance from American Botanists, who have most liberally presented their published works. My thanks are more especially due to Prof. T. S. Brandegee, Dr. N. L. Britton, Mr. H. Pittier, Dr. B. L. Robinson, Dr. J. N. Rose, Captain J. Donnell Smith, and Dr. W. Trelease.—W. B. H.

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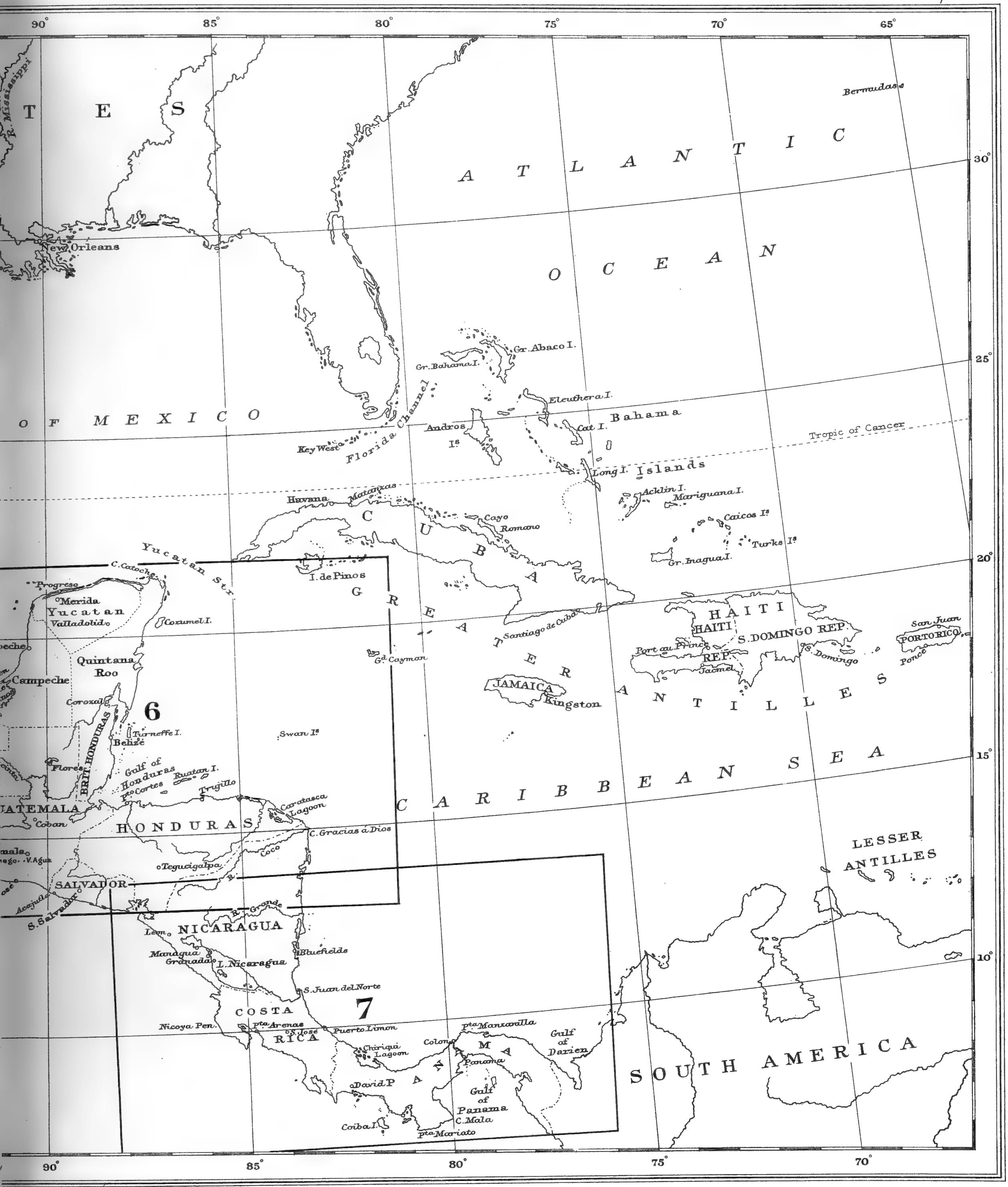
MAPS I.–VIII.

Biol. Centr. Am.

KEY TO MAPS 3 — 7 of MEXICO AND CENTRAL AMERICA

Scale 1:12.000.000 or 1 Inch = 189 Stat. Miles

50 0 100 200 300 400


90°
85°
80°
75°
70°
65°
30°
25°
20°
15°
10°
T E S
R. Mississippi
New Orleans
A T L A N T I C
O C E A N
Bermudas
O F M E X I C O
Gr. Abaco I.
Gr. Bahama I.
Eleuthera I.
Key West
Florida Channel
Andros Is
Cat I.
Bahama
Islands
Tropic of Cancer
Long I.
Acklin I.
Mariguana I.
Caicos Is
Turks Is
Gr. Inagua I.
Havana
Matanzas
Cayo Romano
C U B A
Yucatan str.
C. Catoche
Progreso
Merida
Yucatan
Valladolid
Cozumel I.
I. de Pinos
G R E A T E R
Santiago de Cuba
Gd. Cayman
HAITI
HAITI
S. DOMINGO REP.
Port au Prince
REP.
Jacmel
S. Domingo
San Juan
PORTO RICO
Ponce
A N T I L L E S
JAMAICA
Kingston
Quintana Roo
Campeche
Corozal
6
Turneffe I.
Belize
BRIT. HONDURAS
Swan Is
Flores
Gulf of Honduras
Pto Cortes
Ruatan I.
Trujillo
C A R I B B E A N S E A
Coratasca Lagoon
GUATEMALA
Coban
HONDURAS
C. Gracias á Dios
Coco
LESSER ANTILLES
Tegucigalpa
SALVADOR
Acajutla
S. Salvador
R. Grande
NICARAGUA
Leon
Managua
Granada
L. Nicaragua
Bluefields
S. Juan del Norte
7
COSTA RICA
Nicoya Pen.
Pta Arenas
S. Jose
Puerto Limon
Chiriqui Lagoon
Colon
Pta Manzanilla
Gulf of Darien
PANAMA
Panama
David
Gulf of Panama
C. Mala
Coiba I.
Pta Mariato
SOUTH AMERICA

Biol. Centr. Am.

Orographical Map of MEXICO AND CENTRAL AMERICA

Scale 1:12,000,000 or 1 Inch = 189 Stat. Miles

50 0 100 200 300 400

Reference

0 2,000 5,000 7,000 10,000 FEET

120° 115° 110° 105° 100° 95°

30° 25° 20° 15° 10°

U N I T E D S T A T E S

G U L F O F M E X I C O

P A C I F I C O C E A N

Yuma
Tucson
El Paso
Altar
R. Grande del Norte
Sonora
Hermosillo
Lower California
Gulf of California
Guaymas
R. Yaqui
Conchas
Carmen
Del Rio
Chihuahua
Chihuahua
Coahuila
Chihuahua
R. Nuevo Laredo
R. Grande del Norte
Sinaloa
Lerdo
R. Nazas
Saltillo
Nuevo
Monterey
Matamoros
Altata
Culiacan
Durango
León
Laguna Madre
Durango
Sierra Madre
Victoria
Tamaulipas
Mazatlan
Zacatecas
Sierra Madre
San Luis Potosi
Las Tres Marias
S. Blas
Aguascalientes
S. Luis Potosi
Tampico
Tepic
Tepic
B. Banderas
Guanajuato
Tuxpan
Jalisco
Guadalajara
Sierra Madre
Hidalgo
Revillagigedo Islands
L. Chapala
Pachuca
S. Benedicte I.
Roca Partida
Socorro I.
Clarion I.
V. de Colima
Morelia
Jalapa
Vera Cruz
Gulf of Campeche
Colima
Colima
Michoacan
Mexico
Tlaxcala
Sierra Madre del Sur
Puebla
Morelos
Alvarado
R. Mescala
Coatzacoalcos
Frontera
Tabasco
B. Petacalco
Guerrero
Chilpancingo
S. Juan Bautista
Sa Madre del Sur
Ayutla
Oaxaca
Oaxaca
Tehuantepec
Acapulco
Salina Cruz
Gulf of Tehuantepec
P. Angeles
Quezaltenango
Champerico

90° 85° 80° 75° 70° 65°

30° 25° 20° 15° 10°

T E S

R. Mississippi

New Orleans

O F M E X I C O

A T L A N T I C

O C E A N

Bermudas

Gr. Abaco I.

Gr. Bahama I.

Florida Channel

Key West

Eleuthera I.

Andros Is

Cat I.

Bahama Islands

Tropic of Cancer

Long I.

Acklin I.

Mariguana I.

Caicos Is

Turks Is

Gr. Inagua I.

Havana

Matanzas

C U B A

Cayo Romano

I. de Pinos

Yucatan Str.

C. Catoche

Progreso

Merida

Yucatan

Valladolid

Coxumel I.

Campeche

Quintana Roo

Campeche

Coroxal

Turneffe I.

Belize

BRIT. HONDURAS

Flores

Gulf of Honduras

pto Cortes

Ruatan I.

Trujillo

GUATEMALA

Coban

HONDURAS

Caratasca Lagoon

C. Gracias á Dios

Coco R.

Tegucigalpa

SALVADOR

S. José

Acajutla

S. Salvador

R. Grande

NICARAGUA

Lem.

Managua

Granada

L. Nicaragua

Bluefields

S. Juan del Norte

COSTA RICA

Nicoya Pen.

Pta Arenas

S. José

Puerto Limon

Chiriqui Lagoon

Colon

Pta Manzanilla

Gulf of Darien

Panama

David

P A N A M A

Gulf of Panama

C. Mala

Coiba I.

Pta Mariato

Gd Cayman

Santiago de Cuba

JAMAICA

Kingston

Swan Is

C A R I B B E A N S E A

HAITI

HAITI

S. DOMINGO REP.

Port au Prince

REP.

Jacmel

S. Domingo

San Juan

PORTO RICO

Ponce

A N T I L L E S

LESSER ANTILLES

SOUTH AMERICA

Biol. Centr. Am.

114° 112° 110° 108°

32° 30° 28°

CALIFORNIA

ARIZONA

NE

LOWER CALIFORNIA

SONORA

SINALOA

Maricopa
Yuma
R. Gila
Mariposa
Colorado
Sa de Sta Clara
Pta Invencible
Rio Colorado
Tucson
Rio San Pedro
Rio Sta Cruz
Benson
Tombstone
Bisbee
Boca Grande
Puerto Isabel
Montague I.
I. Gore
Quitovaquita
Sonoyta
R. de Sonoyta
Antonio
Quitovaca
Sta Crux
Pozo Verde
Sasabe
Hacienda de Benificio
Coxon
Sonoi
Sierra Pinta
Tren
Rafael
Sombreretillo
Hamos
Nogales
Naco
Douglas
Sta Cruz
Agua Zarca
Del Rio
Cananea
Ronquillo
Fronteras
Batepito
Rio Casas Grandes
B. Adair
Pta Peñasco
G. de C.
B. S. Felipe
B. Jorges
I. S. Jorge
Juarez
Rio Seco
Saric
Salada
S. Marcos
S. Francisco
Rio Altar
Tubutama
Inubris
Terrenate
S. Ignacio
Rio Los Alisos
Rio Asuncion
Alamos
Caborca
Oquitoa
Altil
Pinacate
Altar
Oquca
Sta Ana
Magdalena
Bacoachi
Prieta
Rio Magdalena
Rio Asuncion
Bamori
S. Luis de los Aros
S. Rafael del Alamito
Placeritos de Nacosari
Arizpe
Barispe
Bacerac
Nacosari Viejo
Rio de Bavispe
Rio de Sonora
Cucurpe
C. Tepoca
Bahia Tepoca
Serna
Bonacita
Puerto
Cruces
Tuape
Querobabi
Sinoquipe
Banamichi
Cumpas
Oputo
Guachinera
Rastritas
Puerto Libertad
C. Lobos
I. S. Luis
Carrizo
Pozo
Opodepe
Huepac
Jécori
Moctezuma
Tortugas
El Burro
Carbo
Aronchi
Rayon
Baviacora
Granados
Guasabas
Hacadehuanchi
Alamos
Pozo Crisante
Casas Viejas
Tazajal
Paso del Negro
Horcasitas
Ures
Tepachi
Pesqueira
Lista Blanca
Zamora
S. José
Tonuco
Pta Arenas
Libertad
Mamito Viejo
S. José Gracia
Alamos
Matape
S. Pedro de la Cueva
Guainopa
Concha
Guainopita
Cebadilla
Madera
Rio Yaqui
Suaqui
S. Rosalia
Nacori
Sahuaripa
Bacanora
Arivechi
Dolores
Rio Casas
Janos
La Noria
Rio Chico
Dr
Bab
I. Mejia
Angel de la Guarda
Canal de las Ballenas
El Infiernillo
C. Tepopa
Tiburon
Partida
Raza
Salsipuedes
I. Animas
Canal de Salsipuedes
HERMOSILLO
S. Enrique
Pta S. Miguel
Pozo Carrizal
Rio de Sonora
Centro
S. Fernando
Willard
Colorada
Vizcaino
Sta Cruz
Pta Kino
S. Vicente
S. Blas
Torres
Palma
Sta Maria
S. Rafael
Pocitos
S. Francisco
Costa Rica
Burras
Moreno
S. Marcial
Alamos
S. José de Pimas
Tecoripa
Soyopa
Huasamopa
Tacupeto
Mulatos
Coconorachi
Bca Kino
I. Turner
S. Esteban
S. Lorenzo
I. S. Pedro Martir
Misa
Reparo
Saqui Grande
Rio Chico
Ortiz
Noche Buena
Sta Rosa
Agua Caliente
Gumuripa
Mayas
Rosario
Molis
Candamena
Batopilillas
Urrachi
Basascar
Yepechic
Tomoc
Pino
Jes
S. Ana
I. S. Pedro Nolasco
S. José
Guaymas
C. de Haro
Cebobampo
Buena Vista
Pitaya
Medano
Potam
Hornos
Baroyeca
Cedros
Quiriego
S. Pedro
Chinapas
Macoyahui
Guasapares
Rio Chinapas
Tobari
Navajoa
Manas Nuevas
Aduana
Babeyhua
Vaca
Choix
Laguna
Baimen
Yecorat
Rio del Fuerte
Rio Mayo
Batopilillas
Urrachi
Tepahui
Conicari
Lomas
Cuaraje
Cocorit
Batacosa
Tejobampo
Cocoraqui
Torotahuacame
Tbran
I. Tortuga
I. Lobos
I. S. Marcos
B. de Lobos
I. Huitulay
I. Cehuare
I. Ciari
Pta Sta Lugarda
P. Rosa
B. de S. Barbara
Estero de Agiabampo
Huatabampo
Sta Cruz Viejo
Mosiaca
Serebampo
Chunaqui
Algodones
Fuerte
Agiabampo
Tehuelo
Sivirijoa
S. Ana
Aguaca

Scale 1: 3,000,000 or 1 Inch = 47·35 Stat. Miles

10 0 10 20 30 40 50 60 70 80 90 100

106° 104° 102° 101 100 99 29 28 27

M E X I C O

T E X A S

C H I H U A H U A

C O A H U I L A

N U E V O L E O

T A M A U L I P A S

D U R A N G O

Del Rio · Jimenez · R. Las Vacas · Porfirio Diaz · R. Escondido · Fuentes · Eagle Pass · Zaragoza · Morelos · Nava · Allende · Guerrero · Leona · Rosales · Pellotes · Rio Grande del Norte

Sabinas · Sabinas Junc. · S. Felipe · Hondo · Columbia · Juarez · Hidalgo · Colombia · Laredo · Nuevo Laredo · Progreso · R. Salado · R. Salinas · Jarita · Rodriguez · Escalera · Mojina · Tanquecillos · Hormigos · Lampazos · Las Tortillas · Lajas · Guerrero · Jose Ramireno · Minas · Vallecillo · Villaldama · Sabinas · Paras · Mier · Joya · Paso Alamo · Agualeguas · Espinal · Palo Blanco · Rio Grande (Davis) · Camargo · Escondida · Treviño

Rincon · W · Deming · Rio Grande · El Paso · Isleta · Seneca · Las Palomas · Juarez · Paso del Norte · Mesa · Pecos · R. Pecos · Medanos · Conejos · Samalayuai · Guadalupe · S. Ignacio · L. Guzman · S. Blas · Guzman · L. de Santa Maria · Los Medanos · Presidio Viejo · Guibnan · Rio Grande del Norte (Rio Bravo) · Candelaria · Banderas · La Amargosa · Ranchería · Ojo del Borracho · Las Vacas · Hueso · Puerto Alto · Pilares · Cuervo · Tres Castillos · La Candelaria · Ojinaga · Presidio del Norte · Rancho · Coyame · Cuchillo Parado · Tinajas · Tasajera · S. Sostenes · Mula · El Nogal · S. Carlos · Rio Conchas · Encantada · Gomez · Las Trancas · Chupadero · Aldama · Dolores · Sta Eulalia · S. Diego · Julimes · Mapula · Horcasitas · Bachimba · Ortiz · Sta Cruz de Rosales · Saucillo · Concha · La Cruz · Camargo · Sta Rosalia · Babisas · Naica · Bustamante · Diaz · La Reforma · Jimenez · Pilar Conchas · Nonura · Humaxiga · El Rosario · Trova · Orion · Vaca · Morito · Parral · Minas Nuevas · Olivas · S. Javier · Caborachic · S. Mateo · Dolores · Corralitos · Carrillo · Gloria · Escalon · Zaralza · Saez · Rio Florido · Mesa de Sandia · El Rosario · Torreon · Villa Ocampo · Tecorichic · S. Jose · Adrian · Allende · Stallorth · S. Barbara · S. Pablo · Balleza · S. Geronimo · Baquiriachic · S. Juan · Guachochic · Temachic · Miñaca · Guerrero · S. Isidro · Concepcion · La Junta · Bachera · Pachera · Temachic · Carretas · Cusihuiriachic · S. Nicolas · Carretas · Carichic · Saguarichic · Roberichic · Bisaquichic · Cusarare · Pamachic · Nararachic · Guadalupe · Guachochic · Muneratachic · Batopilas · Satevo · Cruces · Muralla · Ojo de Agua · Animas · Ortega · Namiquipa · Rincon · Yepomera · Providencia · Temosachic · Tejolocachic · Bachiniva · Cuthiachic · Minaca · Altos · Nuevo Casas Grandes · Galeana · Ojo Caliente · Alamos de Peña · Moctezuma · Chivalito · Gallego · Puerto · Laguana · Agua Nueva · Encinillas · Tbrreon · Sauz · Tepeguanas · Encinos · Plan · S. Lorenzo · Buenaventura · S. Miguel · Cruces · Namiquipa · Rincon · Yepomera · Providencia · Temosachic · Tejolocachic · Bachiniva · Cuthiachic · Minaca · Guerrero · Sabinal · Carrizal · Ahumada · S. Jose · L. de Patos · S. Pedro Jr. · Corralitos · Nuevo Casas Grandes · S. Luis · L. de la Vieja · L. Gavilan · Rio de S. Maria · Rio Carmen · Rio del Carmen · Aldama · S. Andres · Sta Isabel · Salas · Mapula · Julimes · Dolores · Chihuahua · S. Juan · Aldama · Concepcion · La Junta · Bachera · Pachera · Temachic · Carretas · Cusihuiriachic · S. Nicolas · Carretas · Carichic · Saguarichic · Roberichic · Bisaquichic · Cusarare · Pamachic · Nararachic · Guadalupe · Guachochic · Muneratachic · Batopilas · Satevo · Cruces · Muralla · Ojo de Agua · Animas · Ortega

Biol. Centr. Am.

108° 106° 104°

26° 24° 22°

SONORA

CHIHUAHUA

DURANGO

COAHUILA

NUEVO LEON

ZACATECAS

JALISCO

NAYARIT

SINALOA

TEPIC

PACIFIC OCEAN

Guaraje Conicuri Tovari Navajoa Lomas Minas Nuevas Alamos Adiana Babopitas Huatabampo Masiaca Sta. Cruz Viejo Serebampo B. de S. Barbara Algodones Agiabampo Estero de Agiabampo Tehuelo Sivirijoa Ocoroni Mayara Charay P. Ahome Ahome Mochicahui Aramurapa Vacas I. Lechuguilla I. Sta. Maria Guasave Nio Bamoa Gatos Sinaloa Bacubirito Sevalito Valle S. Benito Mocorito Tamazula Amole Angostura Playa I. Sn. Ignacio I. Macapule Alicama Bacamacari Badiraguato Bamopa Motonico Tepuche Culiacancito CULIACAN Altata Satayo Higueras Quila Flechas Tapias Rastra Alaya Cosala Huisachal Abuya Aguanueva Elota Escalera Coyotitan Quelite P. Piaxtla Noria Espinal Sisqueros P. Gruesa Chilillo I. Pajaros I. Venado Mazatlan Villa Union Cocalotan Concordia Chuchla Escuinapa Rosario Juntas Iguana Jacobo Guasima S. Ignacio S. Juan S. Javier Ajoya Tonila Ixcuintla Habas Cohuitaca Tecorichic Yedra Chisorato Aguacaliente Copalquin S. Luis Gonzaga Humariga El Rosario Rocheachic Temachic Guachochic Caborachic Baquirachic S. Miguel Satevo Guadalupe Guadalupe y Calvo Guerrero Batopilas Munerachis Juntas Choix Laguna Bamicora Yecorato S. Ana S. Jose Sierra Mojada Rincon L. Guimbalete Diaz La Reforma Jimenez Trova Vaca Orion Minas Nuevos Morito Parral Dolores Carrillo Gloria L. Palomas Corralitos Hallazgo S. Juan S. Mateo S. Geronimo S. Barbara S. Pablo Mesa de Sandia El Rosario Adrian Allende Stalforth Rio Florido Escalon Zavalza Saex Torreon Villa Ocampo Hidalgo Yermo Conejos Descubridora Tlahualilo Tlahulilo El Oro Inde S. Bernardo Bermejillo Mapimi S. Ped Gomez Palacio Torreon Lerdo Villita S. Pedro S. Luis S. Catarina Cabrera Tepehuanes Santiago Papasquiaro Rodeo Nazas Coneto Blanco Cuencame S. Juan del Rio Canatán Panuco S. Clara Durango S. Esteban Nombre de Dios Santiago Sombrerete Mexquital Chalchihuites Suchil Fresnillo Zacatecas Tacaicaringa Leiras Pueblo Nuevo Concordia Rosario Quiriquinta Tenaraca Huejuquilla Valparaiso Huejucar Bolaños Mezquitic Colotlan S. Maria Ocotan S. Dionisio Huazamota Totatiche Chimaltitan Tlaltenango Yesca Compostela Ahuacatlan Ixtlan Zapopan Mexquital del Oro S. Cristobal Cuq Juchipila Noc Magdalena Tequila Amatitan Zapopan Ahualulco Tala GUADALAJARA Tonala Etzatlan S. Marcos Carabatos S. Sebastian Tuxpan Guadalupe S. Martin Mexcaltitan Paramita Rosa Morada Acaponeta Concepcion S. Felipe Huajicori Escuinapa Chimela Iguanamota Cañas Culiacancito Culiacan Altata Las Tres Marias I. Isabel I. S. Juanito I. Maria Madre I. Magdalena I. Cleofas P. Mita Tres Marietas Peñas

Scale 1: 3,000,000 or 1 Inch = 47·35 Stat. Miles

10 0 10 20 30 40 50 60 70 80 90 100

102° 100° 98° 26° 24° 22°

COAHUILA
TEXAS
NUEVO LEON
TAMAULIPAS
ZACATECAS
SAN LUIS POTOSI
AGUASCALIENTES
GUANAJUATO
QUERETARO
GULF OF MEXICO

Hermanas, Ocampo, San Buena Ventura, Sacramento, Abasolo, Cuatro Cienegas, Nadadores, Monclova, Juncal, Pozuelos, Castuños, Floria, S. Marcos, Bujan, Joya, San Antonio, Espinal, Guadalupe, Corral, Delicias, Escalera, Mojina, Tanquecillo, Hormigas, Lampazos, Las Tortillas, Rio Grande del Norte, Lajas, Guerrero, S. José Ramireno, Vallecillo, Minas, Villaldama, Sabinas, Paras, Mier, Rio Grande (Davis), Camargo, S. Miguel de Camargo, Hidalgo, Reynosa, Brownsville, Matamoros, Paso Alamo, Aguategua, Polo Blanco, Escondida, Treviño, Cerralvo, Aldamas, Mina, Higueras, Carmen, Salinas, Marin, D. Gonzales, Herreras, Cos, Garcia, Bravo, Pesqueria, Topo, Juarez, China, Los Ramones, Mumbre, Enzinas, MONTERREY, Caderyta, S. Juan, S. Pedro de Colonias, S. Isidro, Boquillas, Ramos Arizpe, Pontezuelas, SALTILLO, Huajuca, S. Pedro, Parras, Viexca, Gral Zepita, Gral Teran, Montemorelos, Guadalupe, Mendez, Laguna Madre, Gloria, S. Teresa, Soldadito, Gomez Farias, Lomo Alta, Burgas, Hualahuises, Petaca, Linares, S. Fernando, Rinconada, Cruillas, Iturbide, S. Nicolas, Carbonera, Ojo de Agua, Ocampo, Encarnación, Mazapilo, Concepcion del Oro, San Juan de Guadalupe, Potrerillos, Garza Valdez, Camarones, Villagran, Ascencion, Carrizos, Hidalgo, Cruz, Jimenez, Morales, S. Rosa, Buenavista, Arramberri, Zaragoza, Padilla, Abasolo, Marin, Rio Nieves, Vanegas, Cedral, Catorce, Potrero, Matehuala, Doctor Arroyo, Limones, Lajita, Miquihuana, Mier y Noriega, Bustamante, Medina, Guadalupe, Ranchito, Cos, Fresnillo, Charcas, Concordia, Venado, Ramos, Moctezuma, Arista, Guadalcazar, Nuevo Morelos, Antiguo Morelos, Victoria, Sierra de la Navidad, Sierra Madre, Jerez, Blanca, Salinas, Ojo Caliente, S. Francisco, Villamueva, Pinos, Rincon Romos, Garcia, Iturbide, Cerritos, Muiz, S. Bartolo, Altamira, R. Tamesi, B. Tampico, Tampico, Pueblo Viejo, Tampico Alto, Escribano, Panuco, Llano Bustos, Tuxpan, Tamiahua, Sierra Otontepec, Chicontepec, Huautla, Tlanchinol, Molango, Zacuntipan, Metlatoyuca, Ahuatlan, Tecolutla, Plateado, Calvillo, Ojuelos, Reyes, S. Maria del Rio, Rio Verde, Fernandez, Zaragoza, Valles, Rayon, Palma, Tamuin, Tancuayalab, Ozuluama, Aquismon, Tancanhuitz, S. Ciro, Tierra Nueva, Arroyo Seco, Lagunillas, Coxcatlan, Tampamolon, Actlo, Xichu, Concá, Xilitla, Tamazunchale, Tantoyuca, S. Diego, Alto Ibarra, Encarnacion, S. Felipe, Tequalticha, Lagos, Tlachiquera, S. Luis Paz, Pozos, Victoria, Atarge, Pisaflores, Jalpan, Chapulhuacan, Orizatlan, Huejutla, Huazalingo, Jacala, Tlanchinol, Chicontepec, Tuxpan, Acatic, Aranda, Piedra Gorda, Irapuato, Chamacuero, Hernal, Cadereyta, Colon, Vizarron, El Doctor, Zimapan, Cardonal, Maxitlan, Tequixtla, Cuscamaro, Salamanca, Pueblito, Silao, Chorro, Rincon, S. Miguel, Leon, Dolores, S. José, S. Miguel Allende, Tolimman, Penamillar, Amales, Mexiquitic, Soledad, Armadillo, Juarez, Pozos, Alaquines, Monies, Tula, Coronel, Gallos, Gomez Farias, Magiscatzin, Quintero, Antiguo Morelos, Nuevo Morelos, Rosita, Xicotencatl, Aldama, L. de S. Andres, Laguna Madre, Mexico

Biol. Centr. Am.

104° 102° 100°

20° 18° 16°

ZACATECAS
Juchipila
Nochistlan
Teocaltiche
Lagos
S.Felipe
Alto Ibarra
S.Diego
Xichu
Tancoyo
Compostela
Ahuacatlan
TEPIC
Ixtlan
Zapotan
S.Pedro
R. Grande de Santiago
Mezquital del Oro
Yahualica
Mitic
S.Juan
S.Cristobal
Cuquio
S.Miguel
Ixtlahuacan
Garabatos
Magdalena
Tequila
Amatitan
Zapopan
S.Marcos
S.Sebastian
P. Mita
Tres Marietas
B.Banderas
Etzatlan
Ahualulco
Tala
GUADALAJARA
Tonala
Acatic
Arandas
Piedra Gorda
Peñas
Mascota
Ameca
Mixtlan
Cuale
Talpa
Tuito
Branador
Atenquillo
Cocula
Tlajomulco
S.Ana
Jocotepec
Chapala
Juanacatlan
Ayo
Atotonilco
Degollado
Penjamo
Piedad
La Barca
Ocotlan
Irapuato
Cuerámaro
Salamanca
Huanimaco
Valle Santiago
Jaral
Celaya
Pueblito
QUERETARO
S.Cruz
Rincon
Silao
Chorro
Leon
GUANAJUATO
Dolores
S.Jose
S.Miguel Allende
Victoria
Atarge
Pozos
S.Luis Paz
Nlachiquera
Tlacuitapa
Amoles
Penamiller
Toliman
Colon
Vixarron
Bernal
Cadereyta
S.Rosa
Chamacuero
S.Juan del Rio
Tequisquiapa
Huichapa
Nopala
Ameaico
Aculco
Tula
Jalt
C.Corrientes
Tuito
Talpa
Cuautla
Ayutla
Tenamatlan
Zacoalco
Techaluta
Juchitlan
Union de Tula
Tizapan
L. Chapala
Ixtlan
Sabuayo
Guarachita
Yurecuaro
R. Lerma
Angamacutiro
Penjamillo
Puruandiro
Huango
Uriangato
Salvatierra
Jereruaro
Acambaro
Cuitzeo
L. de Cuitzeo
Zamora
Purepero
Tangancicuaro
Coeneo
Chilchota
Cheran
Paracho
Quirogo
Zinapecuaro
Maravatio
Contepec
Tepeji Rio
Huchuetoca
Teoloyucan
Tamatlan
Ejutla
Sayula
Quitupan
Atoyac
Autlan
Purificacion
S.Sebastian
Tuxcacuesco
Guzman
Toliman
Zapotitlan
Vol. de Nevado 14116
Vol. de Colima 13943
Zapotiltic
Tecalitlan
Mamey
Alvarez
COLIMA
Coquimatlan
Ilotlan
B.Perula
Chamela
B.Tenacatita
B.Manzanillo
Manzanillo
COLIMA
Ixtlahuacan
Tecoman
Tancitaro
Paracuaro
Ario
Tepalcatepec
Tumatlan
Pinandaro
Apatzingan
Tecario
Tacambaro
Tamaccuaro
MICHOACAN
Uruapan
S.Clara
Reyes
Perillan
Patzcuaro
L. de Patzcuaro
Tiricuaro
Chaputuato
Acuitzio
Juanapeo
Etacuaro
Zitacuaro
Donato Guerra
Curuanpasco
Tuxpan
Angangueo
Irimbo
Victoria
Almoloya
TOLUCA
Capul
Valle de Bravo
Tenascaltepec
Susurnato
Tuzantla
Tepuxilco
S.Antonio
Copandaro
Curacuaro
Sultepec
Amatepec
Tlatlaya
Zacualpa
Ptc Iscilo
Guerrero
Tenan
CUERNAV
Taxco
Balsas
Pomaro
Zirandaro
Cutzamala
Coyuca
Iguala
Ocula
Teloloapan
Tlapehuala
S.Cristobal
Ajuchitlan
Coacoyula
Miguel
Balsas
Mezcala
Xochipal
Tepuntitlan
Venta de Zopilote
Coatepec
Amul
Tixtla
Yolotla
Huacuila
S.Francisco
Sierra Madre Del Sur
CHILPANCINGO
Omiltemec
Jaleaca
Amojileca
La Luna
Acaguiz
S.Barbara
Naxco
Tecpan
Atoyac
S.Geronimo
Zapote
Coyuca
Tecpa
Ay
Acapulco
S.Marcos
Tepetixpa
S.Luis
Potatlan
Calvario
Agua Correa
Pantla
Union
Chautla
Tenalhuacan
Mixtla
Orilla
Salada
Silualanejo
B.Petatlan
B.Petacalco
B.Tequepa
Bucerias
Maruata
Pacific Ocean

114° 112°

19°

Roca Partida
San Benedicte I.
C. Middleton
Rock Is
C. Henslow
Socorro I.
C. Rule
Braithwaite B.
REVILLAGIGEDO ISLANDS
Clarion I.
Sulphur B.

Scale, 1:3.000.000 or 1 Inch = 47·35 Stat. Miles.
10 0 10 20 30 40 50 60 70 80 90 100

98° 96° 94°

20° 18° 16°

G U L F O F M E X I C O

P A C I F I C O C E A N

Tampacan · Aotla · Xilitla · Tantoyuca · Lobos · Tamiahua · Tantima · Sierra Otontepec · Tamazunchale · Pisaflores · Chapulhuacan · Orizatlan · Huejutla · Huazalingo · Hudula · Jacala · Chicontepec · Tuxpan · Tlanchinol · Molango · Metlaltoyuca · Tihuatlan · Zimapan · Zacualtipan · Cardonal · Meztitlan · Lemiquilpan · Metzquititlan · Papantla · Tecolutla · Chilcuautla · Atotonilco · Tenango · Actopan · Chico · Omitlan · Apulco · Nautla · Huauchinango · PACHUCA · Real · Tulancingo · Bravos · Epazoyucan · Martinez Torre · Tlapacoyan · Misantla · Huejapoztla · Zempoala · Zacatlan · Zacapoaxtla · Tezintlan · Tetela · Jalacingo · Altotonga · Tlacolulan · Nautla · Las Vigas · Almolonga · Perote · Nauhcampatepetl (Cofre de Perote) 14048 · JALAPA · Contepec · Xico · Plan del Rio · Tlaxmalac · S. Carlos · La Antigua · Teocelo · Quimixtlan · Paso de S. Juan · Vera Cruz · Huatusco · Soledad · Coscomatepec · Vol. Citlaltepetl (Orizaba) 18701 · Tonayan · Paso del Macho · Medellin · Popocatepetl 17887 · Iztaccihuatl Vol. 17342 · Vol. de Malinzin 14636 · Nopaluca · Pinal · Cholula · PUEBLA · Amozoc · Tepeaca · Chalchicomula · Cordoba · Fortin · Atoyac · Potrero · San Lorenzo · Tecamachalco · Esperanza · Orizaba · Cotaxtla · Tlaltetela · Alvarado · Malpaso · Morelos · Zongolica · Molcajac · Tlacotepec · Tlaquilpan · Mixtlan · Previdio · Motzorongo · Tetela · Tlacotalpan · Vera Cruz · Vol. S. Martin · Acula · S. Andres Tuxtla · L. Catemaco · Naranjos · Cosamaloapan · Tlacojalpan · Tepejisoda · Chietla · Tehuacan · Cinco Senores · Ahuatempan · Tehuitzinco · Tonacatepec · Zapotitlan · Coxcatlan · Soyaltepec · Huautla · Tlacojalpan · Pajapan · Mecayapan · Paraiso · Comalcalco · Tonala · TABASCO · Jalpa · Cunduacan · Coatzacoalcos · S. JUAN BAUTISTA · Cardenas · Minatitlan · Xaltipan · Acayucan · Paso S. Juan · Playa Vicente · Sochiapa · Jalle · Hidalgotitlan · Zanapa · Huimanguillo · Nuevo Cacao · Juarez · Ermita · Tenpa · Pichucalco · Sayula · Villa Alta · Chinantla · Tetitlan · Cuatzapan · Ojitlan · Tuxtepec · Tecomavaca · Quiotepec · Valle Nacional · Ozumacin · Cuicatlan · Lachixila · Yuvego · Yasoni · Tenetze · Yazona · Chinantla · Jayacatlan · Ixtlan · Huitzo · Ixtepeji · S. Juan del Estado · Totontepec · S. Lucrecia · Chichicastepec · Cajones · Ayutla · Atitlan · Quesaltepec · Juquila · Cuichicovi · Tlacolula · Cholula · OAXACA · Zimatlan · Pablo · Miltepec · Ocotlan · Mitla · Petapa · Barrio · S. Miguel · S. Maria · Niltepec · Espinal · Juchitan · Zanatepec · Tapana · Ixhuatan · Tehuantepec · Salina Cruz · B. Ventosa · Huilotepec · Tequisistlan · Jalapa · S. Geronimo · S. Carlos · S. Bartolo · Guiechapa · Mixtepec · Miahuatlan · S. Miguel · S. Juan · S. Maria · Rio Hondo · S. Lucas · S. Marcial · Quigolani · Xahica · Huamelula · Astata · Lexicha · S. Pedro · Teotepec · Zacatepec · S. Ana · Tututepec · Magdalena · Mixtepec · Pochutla · P. Angeles · B. Chacahua · B. Escondida · Tecoanapa · Juchitan · Ometepec · S. Juan · Tepenistlahuaca · Jamiltepec · Yolotepec · Copala · Nexpa · S. Luis · Nuevo · S. Martin · Mixquichan · Concordia · Coapinola · Tlaxcalantongo · Tlaxcala · Totomistlahuaca · Atlamajalcingo · Tlaxiaco · S. Bartolome · Mixtepec · Juxtlahuaca · Tlacoapa · Quechattamango · Tecomitla · Colotlipa · Zacatipa · Tlapa · Atlixtac · Chilapa · Zitlala · Ipango · Tonala · Coatlahuaca · Huajuapan · Xochimchuacan · Cualo · Ahuacotzingo · Chiatla · Tepascolula · Silacayapan · Nochistlan · Tenancingo · Toltzingo · Chila · Acatlan · Tequicistepec · Cuatzalan · Chiautla · Tehuitzinco · Ahuatempan · Tepejisoda · Matamoros · Izucar · Tepalcingo · Jojutla · Xantetelco · Xoxocatepec · Cuautla · MORELOS · Yautepec · Atlixco · Amecameca · Cholula · Chalco · Texmelucan · Tlaxcala · TLAXCALA · Barron Escandon · Huamantla · Libres · Tlaxco · Apam · Otumba · Tecamulca · Texcoco · MEXICO · Tlalpam · Xochimilco · Coyoacan · Tlalmanalco · Amecameca · Ayotzingo · Chalco · Tlapacoya · Zempoala · Huipoxtla · Epazoyucan · Real · Omitlan · Chico · Actopan · Chilcuautla · Chapantongo · Tepetitlan · Lemiquilpan · Metzquititlan · Meztitlan · Zacualtipan · Zimapan · Cardonal · Molango · Chapulhuacan · Pisaflores · Tamazunchale · Xilitla · Aotla · Tampacan · Tantoyuca · Tantima · Tamiahua · Lobos

Biol. Centr. Am.

92° 90° 88° 18° 16° 14°

GULF OF MEXICO

PACIFIC OCEAN

CAMPECHE · Lerma · Seiba Playa · Champoton · Sahcabchen · Hopelchen · China · Pocyaxun · Konchen · Seybacabecera · Sihochac · Boloncheon · Rioh · Niop · Cahuich · Zaitalchen · Maspich · Macanche · Becanché · Barbachano · Hubride · Pustunich · Sahcaba · Sabancuy · Pto Escondido · Thabusil · Chicbul · Tanché · Carolina · Carmen · I. Carmen · B. S. Pedro · Frontera · Atasta · Sitio Viejo · Xicalango · R. Mamantel · Mamantel · LAGUNA DE TERMINOS · S. Antonio · Konhaus · Tres Cruces · Sayab · Concepcion · Paraiso · Comalcalco · Cunduacan · Jalapa · S. JUAN BAUTISTA · Cardenas · La de Matillas · L. Chichicaste · Palizada · S. Joaquin · S. Roman · L. de Chacs · Palmar · S. Isabel · Chuncruz · Chinchanha · Icaiche · Jonuta · Isla del Chanal · S. Felipe · R. Julubal · S. Carlos · Gaquillo · Nuevo Cacaos · Macuspana · Tapetitlan · Yeladero · Balancan · S. Ana · Estapilla · Tenosique · Jaurez · Jalapa · Ernata · Teapa · Tacotalpa · El Salto · Montecristo · Palenque · Pichucalco · Sayula · Moyos · Sabana · Menché (ruins) · S. José · El Portal · Tapiluta · Tumbala · Cambio · S. Ramon · Pantepec · Tapalapa · Sujavel · Real · Quechalac · Copainala · La Gloria · Yajalon · Chilon · Ocosingo · Chicoasen · S. Vicente · S. Fernandoo · Sayulo · TUXTLA · Testaquin · Tenejapa · Sanere · S. Martin · R. Jataté · Tiquipilas · Chiapa · Ixtapa · S. Cristobal · Ecatepec · Suchiapa · Totolapa · Vergel · Baja · Bitlar · Amatenango · Yaxcha · S. Bartolomé · Comitan · Catarina la Grande · Chachi · Zayatitan · El Carmen · Tamazulapa · Zapaluta · Concordia · S. Vicente · Gracias a Dios · Espiritu Santo · Pijijiapan · Chiconcuelo · Cuchu · Mapastepec · Maxapa · Acapetagua · Nueva · Tapachula · S. Benito · B. Soconusco · Ocos · Huanuchal · Caballo Blanco · RETALHULEU · Crananados · Champerico · Culco Viejo · Tacana · S. Miguel · Tejutla · SAN MARCOS · S. Pablo · Papapita · S. Clara · Tepanac · Pedro · Atitlan · MAZATENANGO · SOLOLA · S. Domingo · Cotales · El Socorro · Carmen · S. Lucia · ESCUINTLA · El Pilar · Naranjo · Playa Grande · La Gomera · S. Jose · S. Istapa · Cap. de Chiquimulilla · R. Guacalate · R. Covolate · R. Madreviejo · R. Nahualate · R. Sis · R. Samala · Rio de la Paz · Pa Remedios · Barra del Sunia · Puerto de la Concordia · Barra de Escalante · Pena de San Juan del Gozo · Pa San Juan · Pa San Sebastian · Rio S. Miguel · Pta Amapala · GOLFO de FONSECA · Tigre · I. Manguera · I. Conchagua · Col. de Jacuran · LA UNION · V. Conchagua · USULUTAN · Vol. Usulutan · Jiquilisco · SAN SALVADOR · Vol. S. Vicente · SAN VICENTE · Mercedes · Algeria · Chinameca · S. MIGUEL · Carmen · S. Lorenzo · LA LIBERTAD · Vol. Izalco · SONSONATE · Acajutla · PUERTO LA LIBERTAD · Vol. Apaneca · ABUACHAPAN · Pascao · SANTA ANA · Chalchuapa · Coatepeque · Opico · Tejutla · CHALATENANGO · Cabanas · SENSUNTEPEQUE · Dolores · CUSCATLAN · COJUTEPEQUE · S. Sebastian · CARANAS · Sicaia · MORAZAN · CHALATENANGO · Guarita · Erandique · Dolores · Masaguara · Jesus Ottara · Siguatepeque · Opotera · COMAYAGUA · El Pital · Cucuyagua · Esquipulas · OCOTEPEQUE · Co Brujo · Sesenti · S. Juan Guancalpa · GRACIAS · Flores · Tenampo · Conal · S. ROSA · S. Barbara · Trinidad · S. Francisco · Ilama · S. Nicolas · M. del Palmo · Vitoria · Tambor · El Pajon · Guastatoya · CHIQUIMULA · Vado Hondo · Jilotepeque · Esquipulas · Alotepeques · Cuje · Metapan · Ojo de Agua · Barbarena · Laybor · JUTIAPA · CUAJINIQUILAPA · Teocoyepeque · Jalpatagua · Axuleo · Moyuto · Chuchuapa · Vol. Guazapa · Jobasco · Cuatepeque · Opico · Ceiba · Tecla · Zacatecoluca · LA PAZ · Vol. S. Vicente · Vol. Usulutan · Jiquilisco · Col. de Jacuran · LA UNION · V. Conchagua · I. Tigre · I. Manguera · I. Conchagua · Lorenzo · Marcala · Opatoro · Cabanas · Reitoca · Caridad · Arambala · Guajoniquil · Pespire · VALLE · Goascoran · NACAOME · S. Lorenzo · Morazan · Progreso · Negrito · Y O · Morazan · Placer · Concepcion · Morillos · Minas · Comayagua · Siguatepeque · Opotera · Jesus Ottara · Masaguara · Tamara · S. Antonio · LA PAZ · Lamani · TEGU · Reitoca · Cabanas · Sicaia · MORAZAN · CHOLUTECA · Trinidad · S. Francisco · Ilama · S. Nicolas · S. BARBARA · S. ROSA · Flores · Tenampo · Conal · Cucuyagua · Esquipulas · OCOTEPEQUE · Co Brujo · Sesenti · S. Juan Guancalpa · GRACIAS · Erandique · Dolores · Masaguara · Jesus Ottara · Siguatepeque · Opotera · COMAYAGUA · El Pital

GULF OF MEXICO

CARIBBEAN SEA

Yucatan

Campeche

Oxkutzcab

Tekax

Peto

Valladolid

Tizimin

Motul

Progreso

Merida

Izamal

Tunkas

Chichen Itza (ruins)

Ticul

Hecelchakan

Bolonchenticul

Hopelchen

Seibal Playa

Lerma

Campeche

Isla Holbox

C. Catoche

Lagartos

Malaga

Contoy

Blanca

Mugeres

Cancun

Cozumel

Pt. Molas

S. Miguel

S. Maria

Pt. Celeran

Tulum

Cheoman

Chancenote

Nohku

Pole

Nabalan

Chemax

Tixcacalcupul

Chikinxonot

Tepich

Uaimas

Tela

Ionot

P. Soliman

Yokik

Bahia de la Ascencion

Santa Cruz

Sucopo

Sucila

Kantunibil

El Meco

Panaba

Gonzalez

Telchac

Ixil

Sisal

Chicxulub

Conkal

Temax

Tekal

Cenotillo

Tixcancal

S. Maria

Ditas

Timun

Sotuta

Teabo

Muna

Mama

Acanceh

Huhi

Xocchel

Uman

Kinchil

Hunucma

Kopoma

Chochola

Opichen

Ajuachao

Pecal

Nunkini

Calkini

Pocboc

Oxkulscab

Ticun

Chacsinkin

Peto

Tixcacal

Nohku

Ticuldahtun

Tulum

Cheoman

Ionot-aké

Sucopo

Swan Is.

Lagartos

Holbox

Yilam

Progreso

Sisal

I. Snake

I. Madagascar

I. Sisal

Hunucma

Kinchil

Merida

Campeche

Hopelchen

Seibal Playa

Lerma

Pocyaxum

China

Konchen

Seybacabecera

Iturbide

Barbachano

Becanché

Saban

Puschakan

Titua

Yucchil

Tepich

Uaimas

Tela

Ionot

P. Soliman

Yokik

Bahia de la Ascencion

Santa Cruz

Tizimin

Sucila

Panaba

Gonzalez

Telchac

Ixil

Chicxulub

Conkal

Temax

Tekal

Cenotillo

Tixcancal

Chancenote

Nohku

S. Maria

Tunkas

Izamal

Motul

Tixkokob

Xocchel

Uman

Kinchil

Hunucma

Kopoma

Chochola

Opichen

Acanceh

Huhi

Muna

Mama

Sotuta

Chichen Itza (ruins)

Ditas

Timun

Nabalan

Chemax

Valladolid

Tixcacalcupul

Chikinxonot

Tixculdahtun

Tulum

Cheoman

Ionot-aké

Sucopo

Kantunibil

El Meco

Malaga

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Cancun

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S. Miguel

S. Maria

Pt. Celeran

Ticul

Oxkutzcab

Tekax

Peto

Ticun

Chacsinkin

Hecelchakan

Bolonchenticul

Calkini

Pocboc

Nunkini

Pecal

Ajuachao

Maxcanu

Opichen

Kopoma

Chochola

Kanchil

Sisal

Progreso

Hunucma

Conkal

Chicxulub

Ixil

Telchac

Gonzalez

Panaba

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Holbox

Yilam

I. Snake

I. Madagascar

I. Sisal

Isla Holbox

C. Catoche

I. Contoy

I. Blanca

I. Mugeres

I. Cancun

El Meco

Kantunibil

Ionot-aké

Sucopo

Sucila

Tizimin

Chancenote

Nohku

S. Maria

Pole

Nabalan

Chemax

Tixcancal

Cenotillo

Tekal

Motul

Temax

Izamal

Tunkas

Ditas

Timun

Sotuta

Chichen Itza (ruins)

Valladolid

Tixcacalcupul

Chikinxonot

Tixculdahtun

Tulum

Cheoman

Pt. Molas

S. Miguel

I. COZUMEL

S. Maria

Pt. Celeran

Ionot

P. Soliman

Yokik

Bahia de la Ascencion

Santa Cruz

Tela

Tepich

Uaimas

Chikinxonot

Chacsinkin

Ticun

Tekax

Peto

Oxkutzcab

Ticul

Muna

Mama

Teabo

Sotuta

Chichen Itza (ruins)

Ditas

Timun

Nabalan

Chemax

Valladolid

Biol. Centr. Am.

88° 86° 84° 82°

12° 10° 8°

HONDURAS
NUEVA SEGOVIA
DISTRITO DE PRINZAPOLCA
DISTRITO DE ZELAYA
DISTRITO DE RIO GRANDE
CHINANDEGA
LEON
MANAGUA
MATAGALPA
ESTELI
JINOTEGA
CHOLUTECA
NACAOME
LAUNION
MORAZAN
LA GOTERA
S. MIGUEL
CHONTALES
JUIGALPA
GRANADA
CARAZO
RIVAS
MASAYA
BLUEFIELDS
LAGO DE MANAGUA
LAGO DE NICARAGUA
I. Ometepe
V. Momotombo
V. Madera
GUANACASTE
ALAJUELA
CARTAGO
SAN JOSE
HEREDIA
PUNTARENAS
LIMON
PENINSULA DE NICOYA
PENINSULA DE OSA
BURICA PENINSULA
GOLFO DE FONSECA
GOLFO DE CULEBRA
GOLFO DE NICOYA
GOLFO DULCE
DIST. DE SAN JUAN DEL NORTE
S. JUAN DEL NORTE
MONTAÑAS DE YELUCA
MONTAÑA DE YALI
CORDILLERA DE TALAMANCA
Rio Wawa
Hill
Waunta
R. Walpasiesa
Prinzapolca
Rio Prinzapolca
Man of War Cays
Tyra Rock
Tyra Cays
Kings Cays
N.E. Cays
Askill Cays
Pearl Cays
P. Pearl Cay
P. Mosquito
Little Corn I.
Great Corn I.
Blowing Rock
Cayman Rock
Bluefields H^r
Bluefield Bluff
Deer Island
Guano Cay
Pigeon Cays
Sister Cays
French Cay
Monkey Pt
Boxaro
Boro I
P. Gorda
Corn River
Spanish Creek
Rio Indio
Harbour Head
L. Agua Dulce
Barra Colorada
R. Tortuguero
Parasmina
R. Pacuare
Grape Cay or Uvita I.
PUERTO LIMON
Colenia
P. Coaita
Puerto Viejo
P. Mona (Carreta)
R. Sixola or Tarire
Boca del Drago
Colombus
Monkey Cay
Water Cay
Rio Grande de Terraba
Isla Caño
P. Salsipuedes
C. Matapalo
P. Burica
I. Montuoso
I. Ladrones
Rio Wawa
Rio Coco
Rio Grande
Rio Bluefields
Rio Rama
Rio Escondido
Rio Prinzapolca
Rio S. Miguel
Rio Choluteca
Rio Choluteca
Rio Negro
Rio Tempisque
Rio Sapoa
Rio Frio
Rio Sarapiqui
Rio Pacuare
Rio Matina
Rio Blanco
Rio Estrella
Rio Sixaola
Rio Chiriqui Viejo
Rio Chiriqui
Rio Fonseca
Rio Lempa
Rio Paz
Rio Sucio
Rio Tamarindo
Rio de Leon
Rio Tipitapa
Rio Malacatoya
Rio Mayales
Rio Negro
Rio Tuma

82° 80° 78° 76°

12°

10°

8°

Roncador Cay and bank

Stª Catalina Hr Old Providence

St Andrew I.

Courtown Cays

Albuquerque Cays

A R I B B E A N S E A

P. Boqueron
Is Duarte
P. Gordo
I. del Muerto
Colon Harbour
Chagres R.
Borda or Donoso
Miguel de la Icacal
P. Manzanillo
Bay San Cristobal
P. Pescador
Palenque
I. Culebra
P. San Blas
MULATAS ARCHIPELAGO
GOLFO DE SAN BLAS
Is Puyadas
Concepcion Cays
Ratones Cay
Piedras Cays
Limones Cay
Pt Mosquito
Navagandi
I. Pinos
P. Sasardi
Sasardi Is
P. Escoces
B. Carreto
B. Anachucaua
C. Tiburon
GULF OF DARIEN
COLOMBIA
SOUTH AMERICA
Portobello
Manzinga
Cami
Sabanosa
Mt St Rita
Colon
Chagres
Puerto Bello
Salud
Conchita
Chepo
Jesus Maria
Juan Diaz
Culebra
Ancon
I. Chepillo
PANAMA & Harbour
Harbour of Ancon
La Chorrera
I. Taboguilla
I. Majagua
Chiman
BAHIA DE PANAMA
I. Taboga
P. Chame
I. Oloque
I. Bona
I. Saroga
I. Chapera
I. Mangue
I. Casaya
I. Pajaros
ISLAS PERLAS
I. Pedro Gonzales
I. S. José
I. Canas
REY (S. Miguel)
P. Patena
S. Lorenzo
I. Galera
P. Garachine
La Palma
North Bay
Coral
I. Resaca
San Miguel
Mareo
South Bay
Real de Santa Maria
Boca de Cupe
Cupiro
Yaviza
Paya
Limon
Cº Pirre
Sta Cruz de Caña
Cerros del Espiritu Santo
SERRANIA DEL DARIEN
Altos de Aspave
P. Caracoles
B. Pinas
P. Pinas
B. Gusgava
P. Cocalito
B. Ardita
Humboldt B.
C. Marzo
B. Octavia
Cº Caledonia
Cº Carreto
Cº Acacachuana
Cº Gardi
Cº Puno
La Palma
Yaviza
Real de Santa Maria
Boca de Cupe
Cupiro
Paya
Limon
Cº Pirre
Sta Cruz de Caña
Cerros del Espiritu Santo
SERRANIA DEL DARIEN
Altos de Aspave
P. Caracoles
B. Pinas
P. Pinas
B. Gusgava
P. Cocalito
B. Ardita
Humboldt B.
C. Marzo
B. Octavia

MOSQUITO GULF
VALIENTE PEN.
C. Valiente
Escudo de Veragua
Old Bess Pt
Buppan Bluff
P. Rincon
P. Polisade
P. Coaita
Belen
Mineral
Cº Santiago
Cº Barranquito
Cº Iglesia
Cº Viejo
Cº la Plata
Remedios
Tole
Blanca
Veraguas
Cº Calovebora
SERRANIA DE TABASARA
Cº Tabasara
Cº Tranjera
Cº Negro
La Pintada
Igabra
Picache
P. Prieto
San Carlos
P. Calabaza
Cº Capira
Cº Grande
Capira
Anton
Pd Pisada
P. Anton
Altos de los Charros
S. Pablo
Las Palmas
Pueblo Nuevo
P. Muertos
Is Contreras
I. Muera
I. Ranchería
P. Brava
I. Gobernador
P. Zurron
I. Cebaco
B. Arena
R. Arena
I. Naranjos
P. Mariato
P. Negada
I. Icaron
I. Icarita
B. Dauds
R. Negro
R. Tareo
Tonosi
P. Guanico
Morro Puercos
Santa Maria
P. Estero
P. Lisa
LOS SANTOS
Guararo
Las Tablas
Pocri
Macaracas
Pedasi
I. Iguana
C. Mala
Rio de Jesus
Parita
Ba PARITA
SANTIAGO
Las Palmas
Panuga
Las Minas
Los Pozos
R. Suay
R. Angula
R. Montijo
R. Guarare
R. Parita
R. Tabasara
R. Chiriqui
R. Chiriqui Viejo
R. Changuinola
R. Calovebora
R. Tranjera
R. Cricamola
R. Caimito
R. Chagres
R. Trinidad
R. Cañazas
R. Santa Maria
R. Estero
R. Parita
R. Guarare
R. Tonosi
R. Arena
R. Negro
R. Suay
R. Angula
R. Montijo

Biol. Centr. Am.

92 91

15 14

R. Chiapas
R. San Gregorio
R. Cuilco
R. Suchiate
R. Coatan
R. Naranjo
R. Tilapa
R. Chixoy
R. Grande
R. Coyolate
R. Guacalate
R. Escuintla
R. Cuilco
R. Chixoy

MEXICO

Nenton
HUEHUETENANGO
Todos Santos
Huehuetenango
S. Sebastian
Salinas
Yaxcamual
Choctun
Cubilguitz
Dolores
Sachicha
EL QUICHÉ
Chajul
Cunen
Uspantan
Coban
Primavera
Balheu
S.Cristobal
S.Cruz
S.Joaquin
Tactic
S.Ana
Potál
Sº Rosa
Sº Tomas
ALTA VERAPAZ
Cubulco
Rabinal
Salama
S.Miguel
Joyabaj
Montaña de Choacus
Rincon
Choatus
S.Cruz Quiché
Momostenango
Sº Tª el Quiché
S.Sebtª Lemoa
Patchoc
Chimente
TOTONICAPAM
SAN MARCOS
V. Tacana
V. Tajumulco
S.Marcos
Rodeo
Malacatan
Totonicapam
Desconsuelo
Saltan
Llano Grande
Canoa
S.Bernardo
Buenaventura
Trapiche Grande
Vuelta Grande
Carrizal
S.Antonio
GUATEMALA
Chinautla
Aceituno
Mixco
Santiago
Chimaltenango
Patzun
Patzitzia
Chicoj
Itzapa
S.Lucas
S.Lucia
SACATEPEQUEZ
Antigua
Barcena
Villabos
Villanueva
Petapa
L.Amatitlan
Acatenango
Duenas
Ciudad Vieja
Capetillo
S.Maria
Calderas
Alotenango
V.Fuego
V.de Agua
Amatitlan
AMATITLAN
Zapote
San Cayetano
Belen
Palin
Pacaya
V.Pacaya
Concepcion
Escuintla
Guanagazapa
Cuajiniquilapa
SANTA ROSA
Torola
Amatillo
Sta. Maria Lizuri
Brito
Gavia
Zinquinala
Mojon
Don Garcia
Mixtan
Masagua
Maquina
Naranjos
Pañan
Paso Antonio
Obero
S.Isabel
San Jose
Istapa
S.Lucia
Puntaleon
Patalul
Mirandilla
Lago de Atitlan
Panajachel
Godines
S.Andres
Tecpan
Solola
Zunil
V.Zunil
V.S.Tomas
Las Nubes
S.Mariu
V.Stª Maria
Concepcion
S.Martin
Cº Quemado
Quezaltenango
Salcaja
Chuvic
Los Encuentros
La Carolina
Ostuncalco
S.Mateo
La Union
El Tumbador
Las Mercedes
Naranjo
S.Benito
Coatepeque
Matasano
S.Felipe
S.Martin
El Reposo
V.Stª Clara
V.S.Pedro
S.Lucas Toliman
Atitlan
V.Atitlan
Pampojilaj
S.Teresa
Chicoy
S.Antonio
Sololá
QUEZALTENANGO
SUCHITEPEQUEZ
CHIMALTENANGO
S.Sebastian
Cuyotenango
Retalhuleu
Mazatenango
Ponan
Panama
S.Agustin
S.Isidro
Idolo
S.Geronimo
Paraiso
RETALHULEU
Ocos
Huamuchal
Acapan
Chiapam
Pto Champerico
S.Ana Mixtan
PACIFICO OCEAN

90 89

PETEN

BRITISH HONDURAS

Gulf of Amatique

R. Sarstoon

Sarstoon

Livingston

Sierra de Santa Cruz

Golfete

Pto Barrios

Chisec

VERAPAZ

Cueva de Lanquin

Cahabon

S.Agn Lanquin

R. Cahabon

S.Felipe

C. de S. Gil

IZABAL

Chiacam

S.Cruz

Tenedores

R. Coban

Danta

Sauce

Lago Izabal

S.Pedro Carcha

S.Juan Chamelco

Senahu

Trece Aguas

Abbotsville

R. Polochic

Panzos

Mico Mountains

Rio Motagua

S.Juan

Izabal

La Unión

Matacan

Teleman

Tamahu

Tucuru

Tinta

Chamiquin

Quirigua

Purula

Sabo

Panima

Ribaco

Monjon

Sinanja

Amates

Chilasco

S.Geronimo

S.Cruz

Gualan

S.Barbara

Sierra de las Minas

Estanzuela

S.Pablo

ZACAPA

El Jicaro

Guacamaya

Troxos

S.Clemente

Tocoy

Zacapa

Rio Motagua

Climalapa

Guastatoya

R. Copan

Copan

Chiquimula

CHIQUIMULA

V. Imay

JALAPA

Quezaltepeque

Jalapa

Esquipulas

Alotepeque

Jutiapa

L. de Guija

JUTIAPA

R. Lempa

R. Margarita

HONDURAS

EL SALVADOR

15

14

Part of
GUATEMALA
showing
Mr G.C. Champion's Route
1879 - 1881.

Scale of Miles

10 0 10 20 30 40

Route